COMPRESSIVE STRENGTH ANALYSIS OF LIGHTWEIGHT AGGREGATE CONCRETE WITH SINTERED FLYASH AGGREGATES

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Abstract—This paper represents the experimental study of utilizing sintered fly ash aggregates as replacement of coarse aggregates in concrete. The main intention in doing so is to make the concrete lightweight. Sintered fly ash aggregates are made from fly ash which is a waste material obtained from thermal power plants. Thus, in this way the utilization of waste can be made to develop lightweight concrete. The coarse aggregates in concrete have been fully replaced by sintered fly ash aggregates. The physical properties on sintered fly ash aggregates have been investigated. Mix design has been done for lightweight concrete and normal concrete as per relevant standard code for grade M-25. Cube and cylinder specimens have been casted for lightweight as well as normal concrete and tested for compressive strength at the age of 7-days and 28-days. Split tensile test have also been performed on cylinder specimens. The unit weight of both the type of concrete has been compared by considering the weight of the cube specimens.

Keywords—Concrete, Sintered Fly Ash Aggregates, Compressive Strength, Split Tensile Strength, Mix Design

1. INTRODUCTION

The ever increasing demand for coal as an energy source generates a growing need for disposing of the waste fly ash which results from burning coal. This problem is growing especially severe in India, where Coal-powered Power Plants provide a bulk of the electricity generation. The management of coal fly ash produced by coal thermal power station is a major problem in many parts of the world. However, its generation tends to increase every year. Although some coal fly ash is used in a range of applications, particularly as a substitute for cement in concrete. Large amount remain unused and thus required disposal.

The use of fly ash for production of sintered fly ash lightweight aggregate is an appropriate step towards utilization of this waste product. Fly ash is finely divided residue, comprising of spherical glassy particles, resulting from the combustion of powdered coal. By heat treatment these small particles can be made to combine thus forming porous pellets or nodules which have considerable strength. The fly ash is mixed with limited amount of water and is first made into pellets and then sintered at a temperature of 1000°C to 1200°C. The sintering process is similar to that used in manufacture of Portland cement. Sintered fly ash is one of the most important types of structural lightweight aggregate used in modern times. It has high strength/density ratio and relatively low drying shrinkage.

A. OBJECTIVES

- To effectively utilise fly ash to produce sintered lightweight aggregates
- To develop structural lightweight concrete
- To study the compressive strength and split tensile strength of lightweight concrete and compare with normal concrete
- To compare the unit weight of lightweight concrete with normal concrete

Abbreviations

SINTAGG – Sintered Fly Ash Aggregates
LWC - Lightweight Concrete
NWC – Normal Weight Concrete

2. MATERIALS

The following materials have been utilized for preparing concrete specimens,
1. Ordinary Portland Cement 53-grade conforming to IS:8112-1989
2. Coarse aggregates of maximum size 10mm conforming to IS:2386-1993
3. Local river sand conforming to Grading Zone-III of IS:383-1970
3. EXPERIMENTAL PROGRAM

A. Physical Properties
The assessment of important physical properties of sintered fly ash aggregates as well as normal aggregates and fine aggregates (sand) has been done.

1) Sintered Fly Ash Aggregates

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<th>PHYSICAL PROPERTIES OF SINTAGG</th>
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The aggregates are porous and thus the value of water absorption is of importance. Care has to be taken that the aggregates do not absorb water during mixing of concrete. To take care of the same, ACI -213R-03 specifies for pre-wetting of aggregates before mixing of concrete to fill up the voids.

2) Normal Aggregates

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3) Fine Aggregates (Sand)

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<th>PHYSICAL PROPERTIES OF SAND</th>
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B. Mix Design

In absence of any Indian Standard Code for mix design of lightweight concrete, here standard code from ‘American Concrete Institute’ has been used. The mix design for lightweight concrete has been done as per ‘ACI 211.2-98 Standard Practice for Selecting Proportions for Structural Lightweight Concrete’

Consider data as follows,
- Grading Zone – III Sand (F.M = 3.0)
- Ordinary Portland Cement (Grade-53) conforming to IS
- Non-air entrained concrete is required
- Lightweight concrete is required for a floor slab having 28-day compressive strength as 25 MPa
- Admixture: Fair Flo Normal Superplasticiser made by Fairmate (Quantity: 300ml/bag of cement)

After a number of trial mixes the following mix design has been established,

<table>
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<tr>
<th>MIX DESIGN FOR LWC-SINTAGG</th>
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<td>Water</td>
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<td>Cement</td>
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<tr>
<td>Coarse Aggregates SINTAGG</td>
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<tr>
<td>Fine Aggregates (Sand)</td>
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</table>

The mix design for normal concrete has been done as per IS 10262:2009 CONCRETE MIX PROPORTIONING – GUIDELINES’

Consider data as follows,
- Specific Gravity of Coarse Aggregates: 2.68
- Maximum Size of Coarse Aggregates: 10mm
- Specific Gravity of Fine Aggregates: 2.86
- Fineness Modulus of Fine Aggregates: 3.0
- Grading Zone-III Sand
- Moisture Content of Fine Aggregates: 2.86%
- Ordinary Portland Cement (Grade-53) conforming to IS
- Non-air entrained concrete is required
- Concrete is required for a floor slab having 28-day compressive strength as 25 Mpa
- Admixture: Fair Flo Normal Superplasticiser made by Fairmate (Quantity: 300ml/bag of cement)

The following mix design has been established,

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C. Tests Conducted

- Compressive Strength
  - Age of Sample: 7-days & 28-days
  - Type of Specimen: Cube
  - Size of Specimen: 150x150x150 mm
- Split Tensile Strength
  - Age of Sample: 28-days
  - Type of Specimen: Cylinder
  - Size of Specimen: Dia=300mm, Ht=150mm
4. TEST RESULTS & DISCUSSION

A. Split Tensile Strength

The split tensile strength for LWC-SINTAGG is lower than that for normal concrete because of the reason that the tensile strength of sintered flyash lightweight aggregates is less than that for normal aggregates. Here the split tensile strength is almost 50% less than that for normal concrete.

B. Compressive Strength

The compressive strength of LWC-SINTAGG is at par with that of normal concrete. However slight decrement is the values may be observed on account of low strength of individual sintered fly ash lightweight aggregate particles as compared to that of normal aggregate particles.

C. Unit Weight of Concrete

The unit weight of LWC-SINTAGG is almost 20% less than that of normal concrete.

5. CONCLUSION

Based on test results, it can be concluded that sintered fly ash aggregates can be effectively used as a replacement of normal aggregates to make lightweight concrete that has sufficient strength similar to normal concrete. Hence lightweight concrete can be used as structural concrete. However, more detailed analysis is required to study the tensile behavior of sintered fly ash aggregates and ways to increase tensile strength of lightweight concrete.

Also, we can achieve almost 20% reduction in dead load of concrete elements by using lightweight concrete. This will also help in effectively utilizing the fly ash waste which is generated in large amount in thermal power plants.

REFERENCES


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[13] ACI 318-08: BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE