EXPERIMENTAL STUDY OF PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH OVER BURNT BRICK ASH

Chelpuri Revathi[1], Riyaz Syed[2], Dr.G Dineshkumar[3]
[1]M.Tech Scholar, [2]Assitant Professor, [3]Associate Professor
Department of Civil Engineering, Vaagdevi College of Engineering
Bollikunta, Warangal, Telangana-506002
Corresponding email id: revathichelpuri1189@gmail.com

ABSTRACT

This project report consists of the strength properties and structural behavior of partial replacement of cement in cement concrete by over burnt brick coal Ash (IV class Bricks). Concrete is an extensively used material in the world. Production of constituents of concrete leads to the depletion of the natural resources as well as it leads to the environmental pollution. Burnt brick coal ash is considered as a waste material in the brick industries. In this study, burnt brick coal ash isused for the partial replacement of Cement. Cement is replaced with Burnt brick coal by 10%, 20%,30%,40% and 50% by weight and compared with the control mix with out any replacement of burnt brick coal Ash. M30 grade of concrete was designed and constant water-cement ratio of 0.45 was used. Mechanical properties of concrete such as Compression strength, Split tensile strength and flexural strength were evaluated. Results showed increase in strength till20%, and then it got reduced for 30%. So, 20% replacement of Burnt brick coal was chosen as optimum value. The Burnt Brick Coal ashcan replace up to20% with Cement.

INTRODUCTION

Concrete is one of the most important construction materials is being used all over the world. It is a compound material composed of fine and coarse aggregate (filler material) nested in a hard matrix of cement (binders) that fills the space among the fine and coarse aggregate particles and bind them together. Concrete's versatility, economy and durability have made the concrete world's most utilized construction material. The cement production adds to pollution environment is a well-known fact to Environmentalists and civil Engineers. The production of cement in large-scale is posing environmental problems on one side and unconditional reduction of natural resources on the other side. Each tone of ordinary Portland cement production leads to the emission of one tone CO2 into the environment.

The objective of this research is to study the feasibility of utilizing the burnt brick coal produced by Brick industries in India as a replacement for Fine aggregate in concrete. Burnt brick coal is a by-product which is produced after firing of brick using coal as a fuel. It is having Cementitious property but its physical properties are similar to sand that is used in this study. Indian brick industry is utilizing 15-20 million tons of coal per year. Indian brick industry is the 3rd largest utilize of coal in India after thermal power plants and steel industries. After China, India is the second largest producer of bricks.

This burnt brick coal is dumped as a waste material and which causes environmental pollution. Burnt brick coal can be used as an alternative to natural sand. Hence the use of Burnt brick coal in concrete as fine aggregate will reduce not only the demand of natural sand but also the environmental pollution and burden. Moreover the incorporation of burnt brick coal will considerably reduce the production cost of concrete. In brief the effective utilization of Burnt brick coal will turn waste material into a valuable resource for the concrete production.

OBJECTIVES

1. To determine the flexural Strength of concrete by partial replacement of cement with burnt brick Ash.
2. TodeterminetheCompressiveStrengthofconcretebypartialreplacementofcement with burnt brick Ash.
3. To determine the Split tensile Strength of concrete by partial replacement of cement with burnt brick Ash.
4. Comparing Above Strength with Normal Concrete by Varying Percentage of 10%, 20%, 30%, 40% and 50%.
5. Todeterminetheusageofoptimumpercentageofabovealternatematerialwith increasing maximum strength with varying percentage of Coal ash.

SCOPEOFTHEPROJECT

i) To study the effect on workability, and strength properties of concrete mix with varying percentage replacement of Cement by burnt brick coal ash.

ii) To find out optimum percentage of Cement replacement by coal based brick burnt for which the concrete yields superior mechanical properties.

iii) To achieve 28 days characteristic compressive strength and hence in the present investigation more emphasis is given to study the concrete composite and to encourage the use of brick burnt Coal ash to overcome.

LITERATUREREVIEW

Siddique (2013) [1]. Carried out experimental investigation to evaluate mechanical properties of concrete mixes in which cement was partially replaced with coal ash. Cement was partially replaced with {10%, 20%, 30%, 40%, and 50%} of coal ash by weight. the test result showed that the compressive strength of coal ash concrete mixes with 10% - 50% cement replacement with coal ash were higher than control mix at all ages. Also the compressive strength of concrete mixes was increasing with increase in coal ash %. This increase in strength due to replacement of cement with coal ash was attributed to pozzolonic action of coal ash. The splitting tensile strength also increased with increase in % of coal ash as replacement in cement. Thetestson flexural strength and modulus of elasticity also showed up improvement in the results as compared to control concrete.

Namagg & Atadero (2009) [2]. Described early stages of a project to study the use of large volumes of high lime coal ash in concrete. Authors used coal ash for partial replacement of cement. Replacement percent from 0% to 50% was tested in their study. They reported that concrete with 25% to 35% coal ash provided the most optimal results for its compressive strength. They concluded that this was due to the pozzolanic action of high lime coal ash. (Jones & McCarthy, 2005) made an extensive laboratory based investigation in to unprocessed low lime coal ash in foamed concrete, as a replacement for cement. For a given plastic density, the spread obtained on coal ash concretes were up to 2.5times greater than those noted on sand mixes. The early age strengths were found to be similar for both cement and coal ash concrete, the 28-day values varied significantly with density. The strength of coal ash concrete was more than 3 times higher than cement concrete. More significantly while the strength of cement mixes remained fairly constant beyond28days, those of coalash foamedconcreteat56and180days wereupto1.7to 2.5 times higher than 28 daysvaluesrespectively.

Rebeiz et al (2004) [3]reportedinvestigation onthe useof coal ashas replacement of cement in polymer concrete. In the weight mix design 15% sand was replaced by coal ash. This replacement of 10% sand with coal ash by weight increased compressivestrength by about 30%. Also there was improvement in the stress strain curve. They also reported good surface finish due to addition of coal ash as replacement of cement which also reduce permeability and have an attractive dark colour. Flexural strength of steel reinforced polymer concrete beams was increased by 15%. When subjected to 80 thermal cycles polymer concrete with coal ash exhibits slightly better thermal cycling resistance (about 7% improvement) than polymer concrete without coal ash.

Neville (2009)[5] In general, the aggregate cement ratio is only a secondary factor in the strength of concrete but it is found that, for a constant water cement ratio, a leaner mix leads to higher strength for higher aggregate cement ratio. A large amount of aggregate absorbs a greater quantity of water. It reduces the effective water cement ratio increasing the strength. The most likely explanation, however, lies in the fact that the total water content per cubic meter of concrete is lower in a leaner concrete. As a result, in a leaner mix, voids form a smaller fraction of total volume of concrete, and it is these voids that have an adverse effect on strength.

MATERIALSANDITSPROPERTIES

CEMENT

Cement is the most important ingredient of concrete. One of the important criteria for the selection of cement is its ability to produce improved microstructure in concrete. The selection of proper grade and good quality of cement is important for obtaining high strength concrete HSC. Some of the important factors, which play a vital role in the selection of the type of cement are compressive strength at various ages, fineness, heat of hydration, alkali content, tricalcium aluminate (C3A) content, tricalcium aluminate (C3S) content, dicalcium silicate (C2S) content and compatibility with admixtures etc., Nowadays practically in site most of the constructions are being done by Ordinary Portland Cement (OPC).

FINEAGGREGATE

Fine aggregate used for HSC should be properly sieved to give minimum void ratio and free from deleterious materials like clay, silt and chloride contamination etc., Grading of fine aggregates should be such that it does not cause increase in water demand for the concreteand should give maximum voids so that the fine cementitious to fill the modulus for making workable and strong concrete.

COARSEAGGREGATE

The coarse aggregate is the strongest and least porous component of concrete. As far asthe shape of the aggregate is concerned, crushed granite coarse aggregate provides better interlocking and hence it helps to achieve higher strength than rounded gravel aggregate. The coarse aggregate meeting the requirements of IS: 383-1970 is suitable for making Concrete. Considering all the above aspects, angular coarse aggregates of maximum size 20mm were taken for the present investigation. As per IS: 383-1970 procedure thespecific gravity of the coarse aggregate obtained as 2.7.

WATER

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. In general, water fit for drinking is suitable for mixing concrete. Impurities in the watermay affect setting time, strength, shrinkage of concrete or promote corrosion of reinforcement. Locally available drinking water was used in the presentwork.

TESTSONMATERIAL

1. NORMALCONSISTENCY

The normal consistencyof a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7mm from the bottomof the vicatmould.

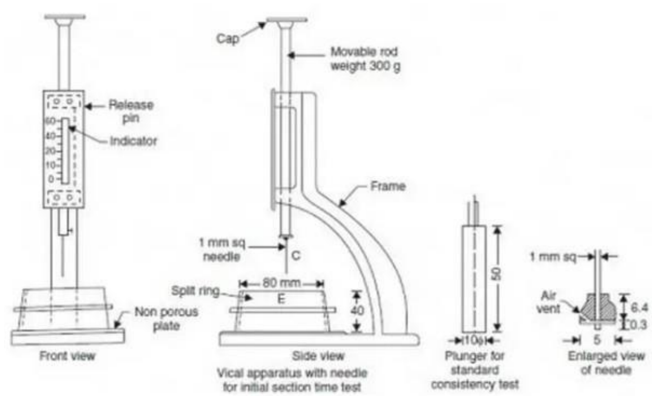

Fig: Normalconsistencyofcement

2. INITIALSETTING TIME

Initial Setting Time: The time period between the time water is added to cement and time at which 1mm diameter needle fails to penetrate the cement paste placed in the vicatmould 5-7mm from the bottom of the mould.

Fig :Initial Setting time ofcement

3. PECIFICGRAVITY

Specific gravity is the ratio of a weight of volume of material to the weight of same volume of water at specified temperature is called specific gravity

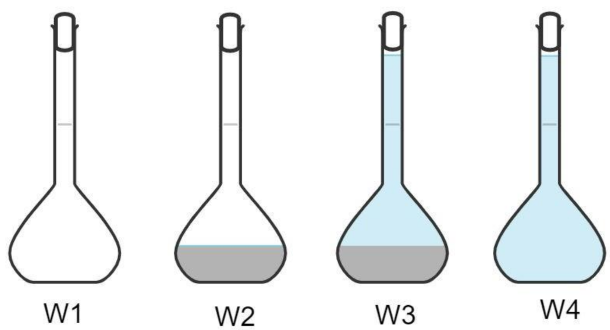

Fig: Specific gravity of cement

4. FINENESSOFCEMENT

Fineness of cement is measured by sieving it on standard sieve. The proportion of cement of which the grain sizes are larger than the specified mesh size is thus determined. 90µ sieve is used for this test.

5. SIEVEANALYSIS

Thetestofsieveanalysisconductedaspe rthespecificationsofIS383:1970aregiv en

FINENESSMODULUS

Fineness modulus of sand (fine aggregate) is an index number which represents the meansize of the particles in sand. It is calculated by performing sieve analysis with standard sieves. The cumulative percentage retained on each sieve is added and subtracted by 100gives the value of fine aggregate.

Finenessmodulus=300.4/100=3.004

6. BULKINGOFSAND

Thebulkingisthepropertyofc hangeofvolumewhenwateris addedtothe material. Bulking is a major problem while mixing the concrete. A measuring jar is taken and sandis filled up-to a mark in the measuring jar.Then water is added up tothehighestmarkin thevesselandleftitforsettlinga ndthesettledheightis measured and the percentage bulking is calculated

7. SPECIFICGRAVITYOFFINEAGGREGATE

The specific gravity isone ofthe important factor that everything depends on thedesignmix also depends on the specific gravity of the materials that we use. As the particle size is less we will use pycnometer for sand. The empty weight of the pycnometer is measuredand then it is filled with sand up to a mark and the weight is measured. Then water is filled with water

MIXDESIGN

TakenM30Grade

Type of Cement OPC53 Grade Size of Coarse Aggregate 20 mm

- Step 1: Target mean strength for mix proportion:(F'ck

= Fck + KxS)

HereFck=30

K=Riskfactor=1.65

S = Standard deviation = 5 Hence

F'ck =30+(1.65x5)=38.25N/mm^2

- Step2:Selectionofwatercontent:

  Maximumwatercontent=186liters(itisselectedbasedonsizeofaggregate)

- Step3:Correctedwatercontent:

  Maximumwatercontentfor20mmslumpis186lit

  If 3% of water is added then 25mm slump will increases Now

  assuming slump as 75mm, then

  W= 186 + [186x (3/100)] x 186

  W=191.58 lit

- Step 4: Calculations for cement content: W/C

  = 0.4

  Here W/C = Water Cement ratio. 192/C

  = 0.4

  Cement=426.67Kg/m3

Step5:Determinationofaggregates:

From (table 3 IS 10262: 2009) zone II and coarse aggregate (20mm) at W/C ratio 0.4.

Volume of coarse aggregate =0.01+0.6= 0.61 m3 Volume of fine aggregate =1-0.61=0.39 m3

Calculations

A) Volumeofconcrete=1m3

B) Absolutevolumeofcement=(C/S.Pgravityofcement)x(1/1000)

=(426.66/3.15)x(1/1000)=0.135m3

C) Volumeofwater=(W/SP.Gravityofwater)x(1/1000)

=192/1x1/1000=0.192m3

D) Volumeofallinaggregate=A-(B+C)

=1-(0.135+0.192)=0.673m3

E) Mass of fine aggregate= Total volume x volume of F.A x S.Pgravity ofF.A x 1000

=0.673x0.39x2.63x1000

=690.29Kg/m3

F) Massofcoarseaggregate=TotalvolumexvolumeofC.AxS.Pgravity of C.Ax1000

=0.673x0.61x2.63x1000

=690.29Kg/m3

DesignMixRatio

WATER	CEMENT	F.A	C.A
192kg/m^3	426.67kg/m^3	690.29kg/m^3	1104.23kg/m^3

CEMENT: F.A: C.A 426.67/426.67

690.29/426.67 1104.23/426.67

1 : 1.61 : 2.58

CONCLUSION

Conclusionsofthepresentprojectworkgivesthefollowing:

1. The compressive strength of concrete mixes decreases with increase in coal ash. The coal ash can replaced up to maximum of 20% and replacements above 20% may not be safe for different concrete mixes.

2. In general, with the increase

of coal ash there is steep increase in strength from 7 to 28 days indicating that early strength of concrete is reduced with increase in coal ash. Alsothe variation in early strength is more than the variation in later strength. Thus, coal ash can has an adverse effect on early strength of concrete.

3, some mixes of higher strength can be economical than mix of lower strength which developsupon the% of coal ash and time of curing.Therefore, itisobserved that the M30 with 20% coal ash gives more 28 day strength and is economical than M40 with40% of coal ash.

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