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A Study on the Flexural Strength of Ternary Blended Beam Without and With Retrofittting

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***Abstract*— This paper summarizes the work on the properties of ternary blended cement concrete containing Rice Husk Ash (RHA) and GGBS.Nowadays,ternary blended concrete is achieving popularity by overcoming the disadvantages of binary blended concrete. Beams were casted with optimum proportion of blend by replacing cement in concrete by 0%,10%,20%,30%.Flexural tests were conducted after 28th day curing. Minimal loading is given and the beam that carries optimum load is taken for retrofitting .The optimum load carried beam is retroffitted with a fibre known as Kenaf.**

OPC-RHA-GGBS ternary cement concrete could be used as lightweight concrete in civil engineering and building works. The observations were critically studied and the different attributes of the various mixes were correlated with the RHA content in the mix.

Keywords-RHA,GGBS,pozzolona ,flexural strength,Kenaf

I. INTRODUCTION

Due to increasing demand of cement in construction industry and to create a sustainable environment cement is replaced by an industrial waste known as GGBS and an agricultural waste known as RHA.Ternary concrete mixtures include three different cementitious materials. This report includes combinations of portland cement, slag cement, and a third cementitious material.

Ternary mixtures can be designed for: high strength, low permeability,corrosion resistance, sulphate resistance, ASR resistance, elimination of thermal cracking.

Ternary blends have been used in concrete exposed to freezing and thawing and de-icing chemicals. Proper air entrainment, adequate curing, and good concrete practices will maximize the ability of any concrete to resist freezing and thawing and de-icing chemicals. A number of mixture proportions have been used with good results. Some paving projects have performed for over five years in severe conditions with no apparent loss of durability.

The optimum mixture proportions for ternary blends, as with other concrete, will be dependent on the final use of the concrete,construction requirements and seasonal considerations. As with other concrete, cold weather will affect the early strength gain and mixture proportions may need to be adjusted to assure job-site performance.

A.Objective of the project

This work mainly deals with the study of flexural strength of ternary blended concrete beam with Ground Granualted Blast Furnace Slag (GGBS) and Rice Husk Ash (RHA) replacing the ordinary Portland cement by 0%,10%,20%,30%**.** The minimal optimum load carried beam is retrofitted using a fibre known as kenaf.

B.Scope of the project

Concrete with SCM often displays slower hydration,accompanied by slower setting and lower early-age strength,especially under cold weather conditions.Most of the SCMs are industrial by-products. These materials are generally not used as cements by themselves, but when blended with OPC, they make a significant cementing contribution to the properties of hardened concrete through hydraulic and/or pozzolanic activity. SCMs are increasingly used in concrete because of the advantage that it reduces economic and environmental concerns by utilizing industrial wastes, reducing carbon dioxide emissions, and lowering energy requirements for OPC clinker production and also it helps to improve the concrete properties, such as workability,impermeability, ultimate strength, and durability, including enhanced resistance to alkali-silica reactions, corrosion of steel, salt scaling, delayed ettringite formation and sulphate attack.

C. GGBS-Ground granulated blast furnace slag

It is obtained by quenching molten iron slag from a blast furnace in water or steam, and hence produces a glassy granular product that is then dried and ground into a fine powder.

Typical Composition and Characteristics of Ground Granulated Blast Furnace Slag

CaO	45 %
SiO_2	34.0%
Al_2O_3	14.0 %
Fe_2O_3	4.0%
MgO	7.0 %

Density - 3.0 g/cm^3
Specific Surface -5,000 cm^2/g
Activity - 87.0 %

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It is mainly used as a mineral additive for concrete production and substitutes for cement.
Slag cement can be used as the main additive..Quenching of iron and GGBS is shown in figure 1.

i. Fresh Concrete
ii. Increases fluidity
iii. Facilitates workability and settlement
iv. Decreases water need
v. Reduces shrinking when dried
vi. Decreases heat of hydration
vii. Slows down heat evolution
viii. Increases density of concrete

Hardened Concrete

i. Increases durability
ii. Increases ultimate resistance
iii. Provides strength development for up to 720 days
iv. Increases lifetime of concrete (app. 200 years)
v. Minimizes alkali-silica reactions in aggregate
vi. Increases resistance to aggressive environments (acid, sulfate, chloride)
vii. Increases high temperature resistance
viii. Reduces thermal cracks

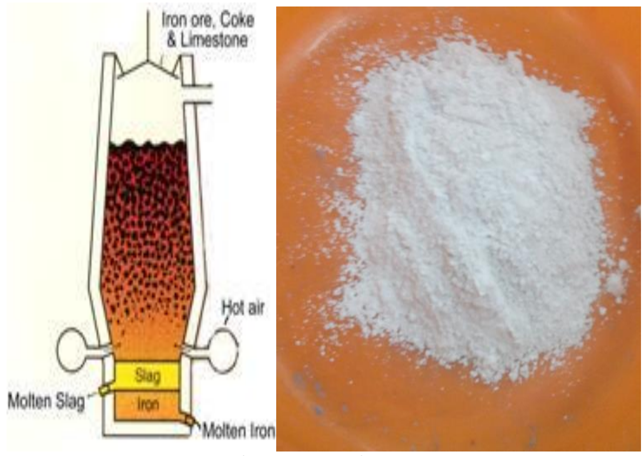

Fig 1 :Process of quenching of iron slag and GGBS.

D. RHA-Rice Husk Ash

Rice milling produces a byproduct known as husk and about 22% of it is rice husk.It contains about 75% organic volatile matter and 25% of weight of husk is converted into ash during firing process.RHA contains around 85%-90% amorphous silica. RHA (25 microns) fills the interstices in between the cement in aggregate.Thus it can reduce the amount of cement in the concrete mix.Typical composition of RHA is given below.

SiO_2	88.32%
CaO	0.67 %
Al_2O_3	0.46%
Fe_2O_3	0.67%
MgO	0.44 %


Fig 2:-RHA –Rice Husk Ash(RHA contains 85%-90% amorphous silica.)

E. KENAF FIBRE

Kenaf fibre is a hibiscus extract. Hibiscus cannabinus is in the genus Hibiscus and is probably native to southern Asia, though its exact origin is unknown. The name also applies to the fibre obtained from this plant. Kenaf is one of the allied fibres of jute and shows similar characteristics. The main uses of kenaf fibre have been rope, twine, coarse cloth (similar to that made from jute) and paper. Uses of kenaf fibre include engineered wood, insulation, clothing-grade cloth, soil-less potting mixes, animal bedding, packing material, and material that absorbs oil and liquids. It is also useful as cut bast fibre for blending with resins for plastic composites, as a drilling fluid loss preventative for oil drilling muds, for a seeded hydromulch for erosion control. Kenaf can be made into various types of environmental mats, such as seeded grass mats for instant lawns and moldable mats for manufactured parts and containers. Panasonic has set up a plant in Malaysia to manufacture kenaf fibre boards and export them to Japan.

Additionally, as part of its overall effort to make vehicles more sustainable, Ford and BMW are making the material for the automobile bodies in part from kenaf. The first implementation of kenaf within a Ford vehicle was in the 2013 Ford Escape. The BMW i3 uses kenaf in the black surrounds. The use of kenaf is anticipated to offset 300,000 pounds of oil-based resin per year in North America and should reduce the weight of the door bolsters by 25 percent.


Fig 3:- Kenaf fibre

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II.METHODOLOGY

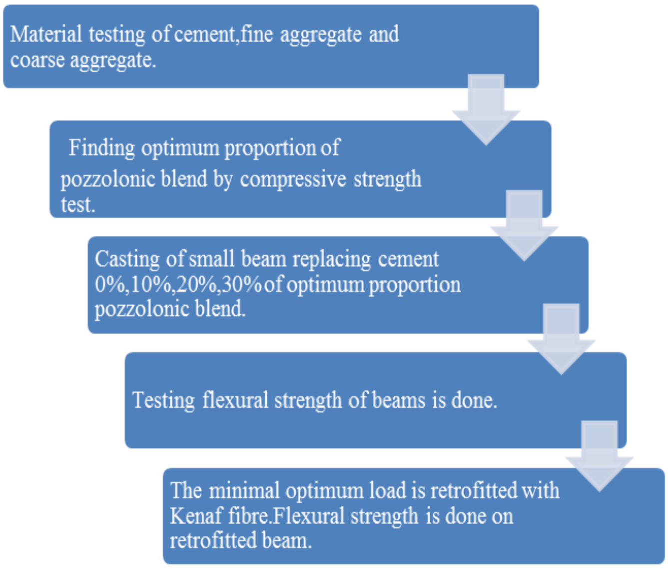

Fig 4: –Methodology flow chart

1) First Step

RHA was collected from Shree Shree Goursundar Rice and Oil mills, Bargarh,Orissa .GGBS was collected from Erode.Kenaf fibre was collected from Chennai.
Material such as cement, sand and aggregates were collected from nearby industrial sources.

2) Second Step

Basic characteristics of cement such as consistency, intial setting time,final setting time,specific gravity were obtained by conducting test. The pozzolona blend of RHA and GGBS taken is 30% RHA and 70% GGBS which has higher compressive strength compared to other pozzolona blends.

3) Third Step

Beams were casted and were tested for flexural strength at minimal loading .The optimum loaded beam is carried with retrofitting with kenaf and again tested for flexural load test.

III.FLEXURAL STRENGTH OF BEAM

Flexural strength also known as modulus of rupture or bend strength is a material property, defined as the stress in a material just before it yields in a flexure test. Two point loading was adopted for beam – pozzolona beam specimens and control beam specimens for finding the flexural strength.

A. Flexure test on unretrofitted beam

Beams were casted by replacement of cement 0%,10%,20%,30% with optimum proportion of pozzolonic blend 30RHA 70 GGBS.Reinforcement given at bottom and top have diameter 6mm.The lateral rings diameter is also 6mm.

Fig 5:-Reinforcement of 6mm dia

Fig 6:- Casting of beams

The mix proportion is calculated and the beams were cast of size 500×100×100.
After one day of setting ,the moulds were removed and the beams were cured using accelerating curing tank.

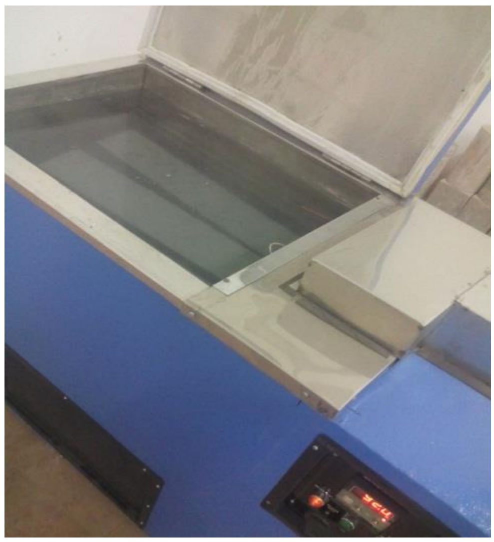

Fig 7:-Curing done with accelerating curing tank

The curing tank is set for 95ºC and the beams were put and closed for one day.This gives a 28 days curing effect.

Fig 8 :-Beams marked for testing

Fig 9:-Flexural strength test at minimal loading.

Flexural test was conducted at minimal loading.The minimal loading flexural strength was more for 10% replacement of cement with pozzolonic blend.The loading was stopped until a small crack was observed in the beam and the load was recorded.

Table 1:- Observation of Flexural strength test at minimal loading

Replacement of cement	Load (k N)	Flexural Strength(N/mm^2)
0%-Conv	25	10
10%-P10	42	16.8
20%-P20	26	10.4
30%-P30	37	14.8

Optimum loading beam got from the observations was for 10% replacement of cement with pozzolona and were retrofitted using a fibre known as Kenaf. Kenaf is a extracted form of hibiscus.

B. Flexural strength test on retrofitted beam.

The beam which has carried minimal optimum loading was taken for retrofitting.

Fig 10:-Retrofitting on three sides of beam

The 10% replacement of cement with pozzolona was retrofitted.After setting ,again the beam is cured for 28 days by using accelerating curing tank.

Fig 11:-Retrofitted beam tested for flexural strength in UTM

The load carrying flexural strength is increased as on retrofication for P10.The breaking load obtained was 45kN. Retrofitted beam carried flexural strength was obtained as 18N/mm^2.

Fig 12:-Retrofitted beam after flexural strength test.

IV.RESULTS OF EXPERIMENTAL INVESTIGATIONS

Mortar cubes of different proportions of pozzolonic blends were tested.The optimum proportion obtained was 30 RHA and 70 GGBS which was taken as pozzolona blend for replacing cement at various proportion.

The minimal optimum load carried for unretrofitted beams under flexural strength test is P10 i.e. 10% replacement of cement with pozzolona blend.

The P10 retrofitted beam carried more flexural strength compared to unretrofitted P10 beam.

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