Evaluating The Potential of Vernacular Materials on the Strength Properties of Concrete

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Abstract- *The making of Ordinary Portland Cement involves enormous size of energy consumption, leading to mammoth discharge of carbon dioxide to the air. This is being great task to the sustainable advance. Cement being the major constituent in building construction, contributes about 7-8% to the emission of greenhouse gases. The environmental impact of carbon dioxide emission due to production of Portland cement can be reduced by partial replacement of cement with supplementary cementitious materials. Sugarcane bagasse ash (SCBA) is a waste material comprising pozzolanic properties but their disposal is causing acute environmental setbacks. The utilization of agricultural waste product in concrete has been a major step on waste reduction. Sugarcane bagasse ash can be effectively used in concrete as partial replacement of cement because of their high content of silica and pozzolanic properties which plays an important role in achieving high strength and durability in concrete. on the other side Palm oil fuel ash could be a byproduct of the palm oil extraction industries found when burning palm kernal pulp that itself is found when the extraction of all economical oil from palm kernals. The disposal of this material is already inflicting environmental issues round the palm oil factories. The present project involves a comprehensive laboratory experimentation study for the application of new waste materials in the preparation of concrete. The main objective of investigation is to study the strength properties of concrete with different percentages replacement of cement with palm oil fuel ash and sugarcane bagasse ash and to study the tensile behaviour on adding with jute fibres.*

Keywords- Palm oil fuel ash, Sugarcane bagasse ash, workability, compressive strength, split tensile strength test, water absorption test, Durability studies.

I. INTRODUCTION

Making of ordinary Portland cement involves enormous size of energy consumption, leading to a mammoth discharge of carbon dioxide to the air, which is being a great task to the sustainable advance. Efforts are required to grow an environmental sociable construction material to reduce release of greenhouse gases to the atmosphere. One of the efforts to reduce the carbon footprint, waste by products used as alternative binders to the cement. Concrete is the second most consumed material in the world after water. The experimental study has been done by partially replacing the ordinary Portland cement bySugarcane bagasse ash and palm oil fuel ash in different percentages. The main goal is to investigate the possibility to improve the strength over a range of palm oil fuel ash percentages.

In the last decades, environmental sustainability has become one of the most important issues. Cement is the most important ingredient of the concrete which produces carbon dioxide which is May harmful. So it is a main concern to reduce the usage of cement. The increase in price of the cement not only will increase the budget of a construction however additionally poses a significant threat to the country's development. it's known that some industrial waste product like nano silica are having some building material and silicious properties. So the use of the commercial and agricultural wastages in concrete part as cement replacement, scale back the price of constructing concrete, additionally causes improvement within the properties of concrete

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The impact of carbon dioxide emission due to production of Portland cement can be reduced by partial replacement of cement with supplementary cementitious materials. Palm ash and bagasse ash is a waste materials comprise pozzolanic properties but their disposal is causing acute environmental setbacks. The utilization of industrial and

agricultural waste product in concrete has been a major step on waste reduction.

The present project involves a comprehensive laboratory experimentation study for the application of new waste materials in the preparation of concrete. The main objective of investigation is to study the strength properties of concrete with different percentages replacement of cement with palm oil fuel ash and sugarcane bagasse ash and to study the tensile behaviour on adding with jute fibres.Fresh concrete tests like compaction factor test and hardened concrete tests like compressive Strength at the age of 7 days and 28 days was obtained and also durability aspect of with palm oil fuel ash and sugarcane bagasse ash and the tensile behaviour on adding with jute fibresconcrete was tested.

The objective of the present study was to investigate experimentally the properties of Concrete with the following test results

1. Workability
2. Compressive strength
3. Flexure strength
4. Tensile strength

II. REVIEW OF LITERATURE

Considering above background, an experimental investigation was carried out to consider the both types and amount of contents of different types of cement and sand replacement materials on the properties of concrete. A lot of work has been done to explore the benefits of using pozzolanic materials in making and enhancing the properties of concrete. Literature review of with palm oil fuel ash and sugarcane bagasse ash and to study the tensile behaviour on adding with jute fibresis presented in the following sections.
Kurein (1981) studied on the coloring behavior of banana fibre. throughout this study four completely different categories of dyes were used on world organization treat, treat cotton fibre and banana fibre. Their dye-uptake, wash-fastness and lightfastness were determined. The dyes elect were dyestuff, vat dye,reactive dye, and dye.

It has been noted that the sunshine fastness of banana fibre is inferior to cotton. this could be attributed to the impurities gift within the banana fibre within the variety of polymer and therefore the different insoluble matter. The revealed analysis works on flexural plasticity of JUTE fiber ferroconcrete beam are studied by several researches D.Y. GAO mentioned the influence of JUTE fiber issue on flexural plasticity of beam and terminated that plasticity indexes increase with increasing of fiber issue.

A.N.Dancygier and Z.Savir studied the influence of JUTE fiber on flexural performance of high strength concrete beam with low longitudinal reinforcement magnitude relation, that tried that JUTE fiber enhance crispiness of beam compared to it of beam with minimum longitudinal reinforcement magnitude relation. Compared to JUTE fiber concrete, the hybrid fiber with completely different kind and size will improve effectively strength and toughness of concrete, kind hybrid result throughout completely different fiber, play various useful influence from completely different level. However, few researches on flexural performance of hybrid fiber strengthened RC beam were studied.

Mr. U.R. Kawade et al., had studied on “Effect of use of pulp ash on Strength of Concrete” that they had with chemicals and Physically characterised and partial replaced within the magnitude relation of 1/3, 10%, 15%, 20%, twenty fifth and half-hour by weight of cement in concrete. The results show that the POFA concrete had considerably higher compressive strength compared to it of the concrete while not POFA. it's found that the cement may be well replaced with POFA up to most limit of V-J Day. though the optimum level of POFA content was achieved with V-J Day replacement. Partial replacement of cement by POFA will increase workability of recent concrete, thus use of Super softener isn't essential.

Mr. R. Srinivasan et al., has investigated on “Experimental Study on pulp Ash in Concrete” that they had ascertained that Sugar Cane pulp is fibrous waste-Product of sugar industry, and inflicting serious environmental drawback that principally contain metal particle and oxide. Hear pulp ash has been with chemicals and physically characterised, and part replaced within the quantitative relation of 1/3, 5%, 15%, twenty fifth by weight of cement in concrete.

Omualdi and Batson (1963) after conducting impact check on fibre concrete specimens, they over that 1st crack strength improved by addition of closely spaced continuous JUTE fibres in it. The JUTE fibres forestall the adverting of small cracks by applying pinching forces at the crack tips and so delaying the propagation of the cracks. Further, they established that the rise in strength of concrete is reciprocally proportional to the root of the wire spacing.

Charles H.Henage (1976) developed an analytical technique supported final strength approach that has taken into consideration of bond stress, fibres stress and volume fraction of fibres. Once his investigations, he all over that the incorporation of JUTE fibres considerably will increase the last word flexural strength, reduces crack widths and initial crack occurred at higher hundreds.

Deb, P. S., Nath, P., & Sarker, P. K. (2014): Sugar cane bagasse ash (SCBA) with mixture of flyash content showing huge improve in the consequences of workability and high strength contrasted with Ordinary Portland Cement (OPC). By changing dissimilar (0%,10% and 20%)contents of Sugar cane bagasse ash (SCBA) with various proportions of flayash content showing a few blemishes, One of them is with increment in SCBA content workability is diminishing simultaneously strength is expanding. By keeping up silicates to alkaline proportions of 1.5 to 2.5 and following ACI 318 and AS 3600 codes for curing we can accomplish above outcomes when contrasted with OPC.

Goriparthi, M. R., & TD, G. R. (2017): He arranged geopolymer concrete consolidating fly ash and Sugar cane bagasse ash (SCBA) as a limiting material, Alkaline materials Sodium silicate (Na2SiO3) and Sodium Hydroxide (NaOH) as activators. And contrasted the consequences of both OPC and geopolymer concrete and closed the accompanying aftereffects of two evaluations of concrete GPC20 AND GPC50. Significant boundaries of corrosive mass misfortune factor (AMLF) by submerging in 5% of H2SO4 solution and strength properties (Compressive, Tensile and Flexure) were resolved..

III. MATERIALS AND METHODS

The experimental investigation work is started with various tests on the constituent materials. The constituent materials are given below.

1. Cement
2. Coarse aggregate
3. Water
4. Sugarcane bagasse ash
5. Palm oil fuel ash

1. Cement

Ordinary Portland cement of 43 grades manufactured by Shree Ultratech Cement was used throughout the Experimental investigation. The quality of the cement was confirming to IS 8112:1989 was used in the field.

2. Fine Aggregate

Fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available river sand passed through 4.75mm IS sieve is applied as fine aggregate conforming to the requirements of IS 383:1970.

3. Coarse Aggregate

Coarse aggregate shall be of hard broken stone of granite shall be of hard stone, free from dust, dirt and other foreign matters. The stone ballast shall be of 20mm and down and should me retained in 5mm square mesh and well graded such that the voids do not exceed 42 percent. Aggregate most of which is retained on 4.75-mmIS Sieve and containing only so much finer material as is permitted for the various types described in this standard.

4. Palm oil fuel ash

Palm oil fuel ash is a waste product of the palm mill industry; this industry extracts oil from oil palms fruits. The palm oil fuel ash is used in this current work was taken from Ruchi industries, Samarlakot.

5. Sugar cane bagasse ash

Sugar cane bagasse ash (SCBA) has recently been tested in some parts of the world for its use as a cement replacement material. The bagasse ash was found to improve some properties of the paste, mortar and concrete including compressive strength and water tightness in certain replacement percentages and fineness.

IV. MIX DESIGN

The property of workability, therefore, becomes of vital importance. The mix design is done as per IS 10262-2009. Percentage dosage of super plasticizer (high range water reducers) is an additional parameter to be considered for designing an OPC mix. Percentage dosage of super plasticizer was fixed as per the mix design method described in IS 10262-2009. Mix proportion was arrived through various trial mixes. The grade of concrete prepared for the experimental study was M35.

V. RESULTS AND DISCUSSIONS

This session provides an outline of the experimental results and endeavors to draw some conclusions. The take a look at result covers the workability, mechanical properties and sturdiness properties of concrete with and while not admixtures. The results of the experimental investigation on Palm oil fuel ash concrete wherever Sugar cane bagasse ash (SCBA) and Palm oil fuel ash has been used as partial replacement of cement in concrete mixes. On commutation cement with completely different percentages the workability, compressive strength, split tensile strength and flexural strength is studied.

5.1 REPLACEMENT DETAILS

The replacement details of Palm oil fuel ash and Sugar cane bagasse ash has been given in the below table. The replacement of cement percentages by 0, 5, 10, 15, 20 and withSugar cane bagasse varying the cement replacement percentagesby 0, 10, 20, 30, 40.

5.2 VARIATION OF SLUMP VALUES

Slump test is used to determine the workability of concrete. The apparatus used for doing slump test are slump cone and tamping rod. Slump test is used to determine the workability of concrete. The apparatus used for doing slump test are slump cone and tamping rod. This is the most commonly used test of measuring the consistency of concrete. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing neither workability, not it is always a representative of the place ability of the concrete. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch. It is performed with the help of a vessel, shaped in form of a frustum of a cone opened at both ends. Diameter of top end is 10cm while that of the bottom end is 20cm, height of the vessel is 30cm, a 16mm diameter and 60cm long steel rod is used for tamping purposes.

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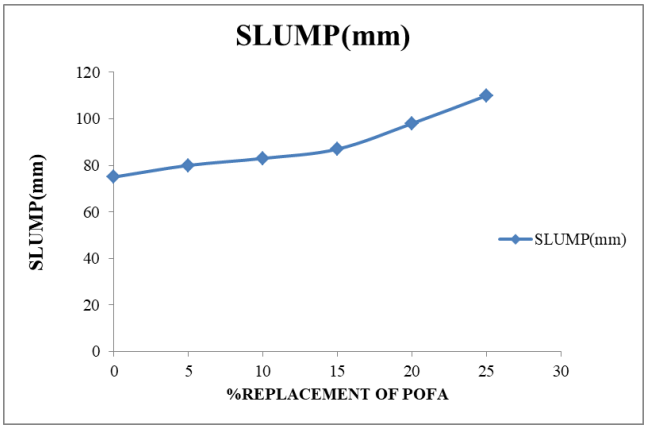
The slump of the freshly mixed concrete was measured by using a slump cone in accordance to ASTM C143. It can be observed from Figure 5.1 that all mixtures have a slump of less than 45mm and are observed that slump values increasing with increase in slag content.



Graph 5.1 Slump valueson replacements

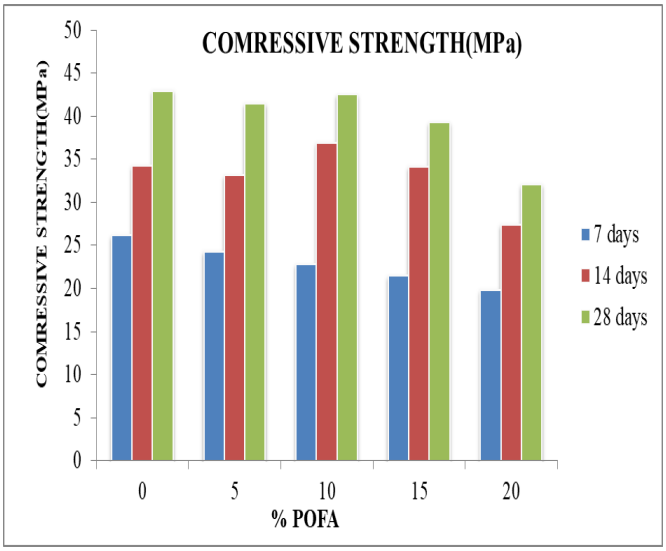
5.3 COMPRESSIVE STRENGTH

The main function of the concrete in structure is mainly to resist the compressive forces. When a plain concrete member is subjected to compression, the failure of the member takes place, in its vertical plane along the diagonal.

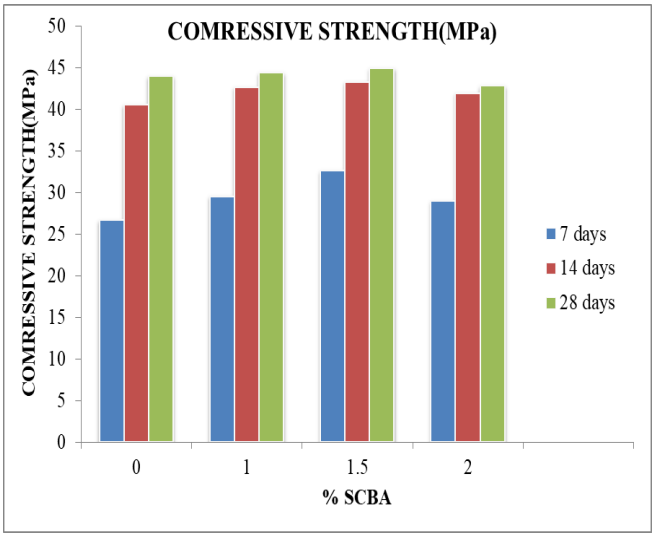
Cubes are prepared of size 150 mm x 150 mm x 150 mm are checked for compressive strength. The specimens tested for 7, 14 and 28 days. The specimen were tested for compressive strength parallel to the plane of the board by applying increasing compressive load until failure occur. The arrangement of load is applied to the specimen by placing the specimen length vertical between the surfaces of the testing machine.

5.4 VARIATION OF COMPRESSIVE STRENGTH FOR DIFFERENT MIXES

Compressive strength of concrete replaced with palm oil fuel ash for curing period of 7-days, 14-days and 28-days respectively and TABLE 6.2 shows the summarized Compressive strength Results for different curing periods– M35 grade.



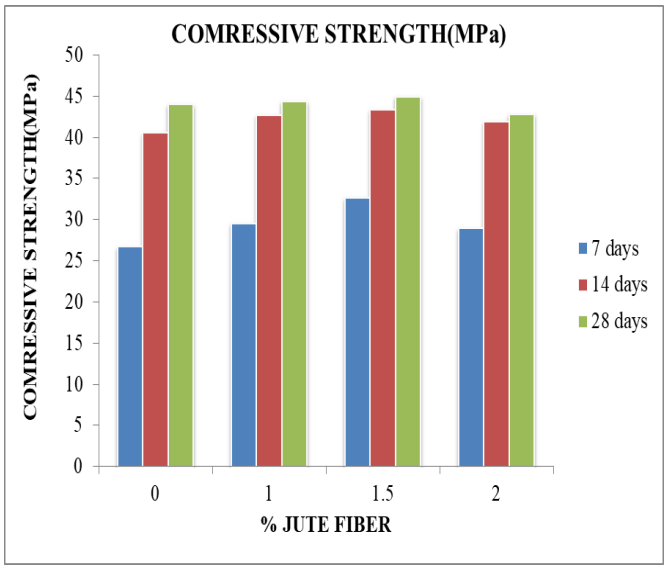
Graph 5.2Plot shows the Variation in Compressive Strength for % Replacement of POFA



Graph 5.3 Shows the Variation in Compressive Strength for % Replacement of SCBA

5.5 EFFECT OF JUTE FIBER ON COMPRESSIVE STRENGTH USING PALM OIL FUEL ASH AND SCBA

The compressive strength of the concrete mix for M-35 with partial replacement of cement by POFA and SCBA respectively showed higher Strength after 7, 14 and 28 days. The 28 days strength of mix with 10% partial replacement of palm oil fuel ash, 20% replacement of SCBA showed higher strength compared to other mixes. Compressive strength of concrete keeping 10% palm oil fuel ash and 20% SCBA as constant and with different percentages of Jute fibre for curing period of 7-days, 14-days and 28-days respectively and Table shows the summarized Compressive strength Results for different curing periods– M35 grade.



Graph 5.4: Plot shows the Variation in Compressive Strength for different percentages of Jute fibres

5.5 SPLIT TENSILE STRENGTH TEST

The size of specimens 150 mm dia and 300 mm length was used and the specimens were cured in normal water. Concrete specimen cubes are used to determine compressive strength of concrete and were tested as per as per IS 516 (1959 Split tensile strength of concrete keeping 10% palm oil fuel ash and 20% SCBA as constant and with different percentages of Jute fibre for curing period of 7-days, 14-days and 28-days respectively and Table shows the summarized Split tensile strength Results for different curing periods– M35 grade..

Compressive stress = $2P/\pi LD \{D^2 / (D-r)-1\}$

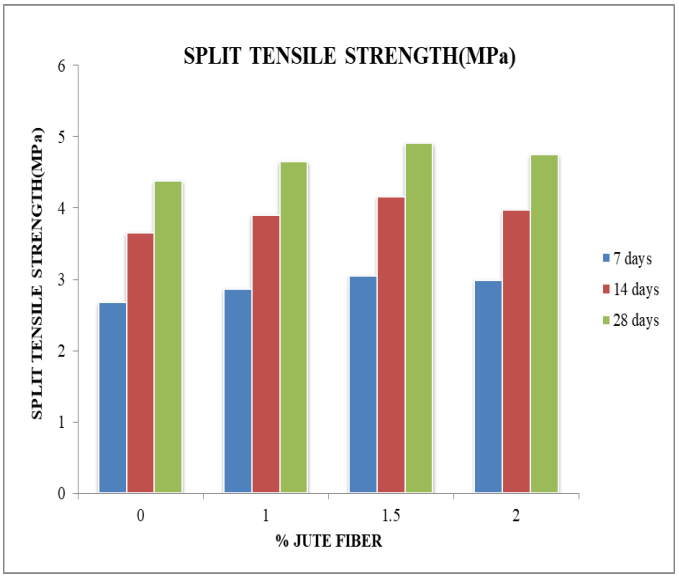
Tensile stress $=2P / \pi LD$

Where, P = Compressive load on cylinder

L = Length of cylinder =300 mm

D = Diameter of cylinder = 150mm

r& (D-r) are distance of the element from the two loads respectively.



Graph 5.5Variation in Split Tensile strength for different percentages of Jute fibres

5.6 FLEXURAL STRENGTH TEST

In the flexural strength test theoretical maximum tensile stress reached at the bottom fibers of the test beam is known as the modulus of rupture. When concrete is subjected to bending stress, compressive as well as tensile stresses are developed at top and bottom fibers respectively. If the largest nominal size of aggregate does not exceed 20mm, the dimension of specimen may be 150mm×150mm×700mm.

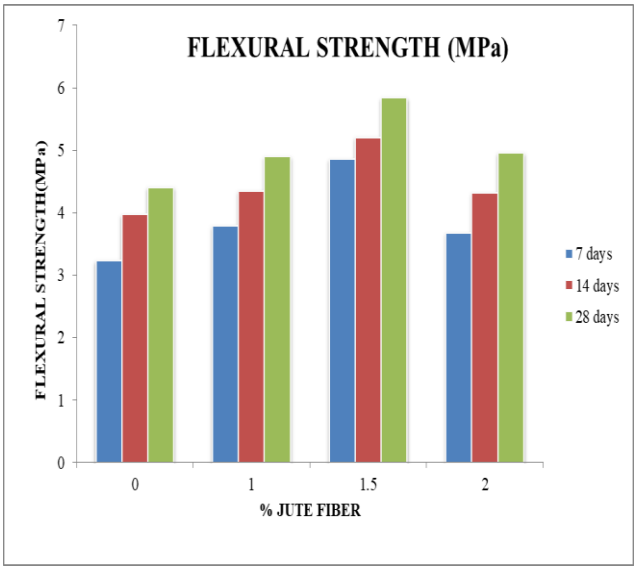
$$f = \frac{M}{Z} = \frac{(PL/6)}{(bd^2/6)}$$

$$f_b = \frac{PL}{Bd^2}$$

When 'a' greater than 20 cm for a 15cm specimen,

$$f_b = \frac{3Pa}{bd^2}$$

The Flexural strength of the concrete mix for M-35 with partial replacement of cement by POFA and SCBA respectively showed higher Flexural Strength after 7 and 28 days. The 7 days and 28 days Flexural strength of mix with 10% partial replacement of Palm oil fuel ash, 20 % replacement of SCBA and 1.5% of Jute fibre showed higher strength compared to other mixes



Graph 5.6Variation in Flexural strength for different percentages of Jute fibres

VI. CONCLUSIONS

The Conclusions and Recommendations that could be drawn from the results of this project and experiments are summarized and the use of Palm oil fuel ash and SCBA as a cement replacing material in concrete production was studied and after the research work is done, the following conclusions were made:

- It has been observed that by the incorporation of Palm oil fuel ash & Sugar cane bagasse ash as partial replacement to cement in fresh and plain concrete increases workability when compared to the workability with reference to concrete made without POFA & SCBA.
- Palm oil fuel ash concrete performed better when compared to ordinary concrete up to 10% replacement of palm oil fuel ash.
- The bond strength exhibited improvement with palm oil fuel ash replacement level. A slight increase in the percentage of strength was observed when compared with conventional concrete for 28 days. Increase of strength is mainly to presence of high amount of Silica in palm oil fuel ash.
- The mix with replacement of cement with 10% Palm oil fuel ash and 20% Sugar cane bagasse ash has shown good strength properties like compressive and tensile and flexural strength. This may be due to the fact that the CSH gel formed at this percentage is of good quality and have better composition.
- The highest compressive strength value i.e. 43.96 MPa, was obtained for a mix having 10% palm oil fuel ash and 20% SCBA.
- It is evident from the present investigation that the addition of Jute fibers to concrete improve compressive strength, split tensile strength, flexural strength etc. of the mix.
- There was 7% increase in the compressive strength and 48% increase in the tensile strength because of the high elastic modulus of Jute fiber. Due to the high tensile nature of jute fibres, resulted in a significant enhancement in split tensile strength.
- The use of Palm oil fuel ash and Sugar cane bagasse ash combined is economic when compared to cement in concrete. Likewise saves a great deal of waste disposal problems and reduces the cement price rise and intensities of CO_2 release by the cement production. Also these materials make the concrete more sustainable, light weight and low energy emitting which is noble.

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