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# STUDY ON THE STRENGTH PROPERTIES OF LIGHT WEIGHT AGGREGATE BY USING COCONUT SHELL AND FLY ASH

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***Abstract:*** ***This research work reports the investigation carried out to determine the use of coconut shell as an aggregate in light weight concrete. Concrete samples were produced with different percentage of replacement, to determine the best and economic proportions that will give acceptable compressive strengths. In the construction, the costs of building materials are rising day by day. The use of alternative material is a partial replace of coarse aggregate in solving part of natural aggregate. The various waste materials are used such as coconut shell, fly ash, furnace slag, paper, rubber, glass etc. So here in my project I will use coconut shell and fly ash waste as replacement of coarse aggregate and fine aggregate by different percentage for making concrete of different grade like M-30. I will use three different proportions of materials. In first proportion, concrete made from coconut shell waste to replace coarse aggregate in different percentage 0%, 10%, 20%. On the other second proportion, coconut shell replace to coarse aggregate 10% and added fly ash to replace fine aggregate 10%. Third proportion coconut shells replace to coarse aggregate 20% and added fly ash to replace fine aggregate 20%. I will prepare cubes, beams and finally slump test, compressive strength test will be conducted to obtain the results for 7 days, 14 days, and 28 days. Three samples specimen will be prepare for each concrete mixes. A large no. of trial mixes are required to select the desired optimum replacement of coarse natural aggregate by coconut shell waste material.***

***Keywords: Coconut Shell, Coarse Aggregate, Light Weight Material, Fly ash, Cement, Fine aggregate.***

## I. INTRODUCTION

There were many experimental work conducted to improve the properties of the concrete by putting new materials ,whether it is natural materials or recycle materials or synthetic materials in the concrete mix. The additional material can be replacing the aggregate, cement or just as additive is natural material. All over the word various measures aimed at reducing the use of primary aggregate and increasing reuse and recycling have been introducing, where it is technically, economically and environmentally acceptable. Researchers are in search of replacing coarse aggregate to form the concrete less expensive and to lead sustainable development. This environment reason has generated a lot of concern in the construction world. The role of sugarcane bagasse, wood chips, plastic waste, fabric waste, polyethylene, rice husk ash, rubber tires, vegetable waste, paper and pulp industry waste, waste glass, broken bricks are some cases of replacing aggregates in concrete.

Concrete is world's most widely used construction material. The utilization of concrete is increasing at a higher rate due to development in infrastructure and construction activities all around the world. In addition, concrete is the 2nd most consumed substance in the world-behind water. Annual production represents one ton for every person on the planet. The concrete are used in all the important project construction such as dams, bridge, building, highway and other runway. The demands of the concrete are increase day by day, year by year depended on the consumption of concrete in various construction projects. Concrete is the best material of choice where strength, durability, fire resistance, impermeability and absorption resistance are required. The main ingredients of the concrete are cement, aggregate, and water. Cement is a binder material in the concrete which bind the coarse aggregate and provide the strength of the concrete and the fine aggregate is the filler materials which fill the voids in the concrete. Aggregate are used in concrete for very specific purposes. Aggregate typically make up about 60% to 75% of the volume of a concrete mixture, and as they are the least expensive of the materials used in concrete, the economic impact is significant. Sources of conventional aggregate occupy the major part of the concrete. Researchers are in search of replacing coarse aggregate to form the concrete less expensive and lead sustainable development The coconut palm is one of the most useful plants in the world. Coconut is growing in 92 countries in the world. Global production of coconut is 51 million hectares nuts from an area of 12 million hectares. South East Asia is regarded as the origin of coconut. The four major players India, Indonesia, Philippine and Shri Lanka contribute 78% of the world production. Disposal of these coconut shells is therefore a serious environmental issue. If the waste cannot be disposed properly it will lead to social and environmental problem.

Coconut shell is categorized as light weight aggregate. Coconut shells have good durability characteristics, high toughness and abrasion resistant properties; it is suitable for long standing use. A large amount of waste coconut shell is generated in India from temples and industries of coconut product and its disposed need to be addressed. Researchers have proposed to utilize it as ingredient of concrete. The study of coconut shells will not only provide a new material for construction but will also help in the preservation of the environment in addition to improving the economy by providing new use for the coconut shells. Therefore attempts have been taken to utilize the coconut shells as coarse aggregate and develop the new structural LWC.

  

## II. LITERATURE REVIEW

Amarnath Yerramala et al. (2012) [1] from structure and materials laboratory of civil engineering, Intel Engineering collage, Anantpur, India were properties of concrete with coconut shell (CS) as coarse aggregate replacement were studied. Control concrete with normal aggregate and CS concrete with 10-20% coarse aggregate replacement with CS were made. Two mixes with CS and fly ash were also made to investigate fly ash effect on CS replaced concrete. Constant water to cementations ratio of 0.6 was maintained for all the concrete. In this research properties like compressive strength, split tensile strength, water absorption and moisture migration were investigated in laboratory. The aim of this work is to provide more data on the strength of coconut shell concrete at different coconut shells replacement and study the transport properties of concrete with CS as coarse aggregate replacement. The result showed that, addition of CS decrease workability and addition of fly ash either as cement replacement or aggregate replacement increase workability of CS concrete and also compressive strength and split tensile strength also decrease with increase in CS replacement. Furthermore, for 28 days of curing addition of fly ash as cement replacement reduced overall split tensile strength of CS concrete and fly ash addition as aggregate replacement showed no major difference with corresponding CS replaced concrete.

Maninder Kaur & Manpreet Kaur (2012) [2] published a review paper in which it is concluded that use of coconut shells in cement concrete can help in waste reduction and pollution reduction. It is also expected to serve the purpose of encouraging housing developers in investing these materials in house construction. It is also concluded that the Coconut Shells are more suitable as low strength-giving lightweight aggregate when used to replace common coarse aggregate in concrete production.

Daniel Yaw Osei (2013) [3] in this experimental study coarse aggregate is partially replaced by coconut shell. Percentages of replacement by coconut shell were – 0%, 20%, 30%, 40%, 50%, 100%. He concluded that CS can be used to produce lightweight concrete and 18.5% replacement of crushed granite with coconut shells can be used to produce structural concrete.

Dewanshu Ahlawat et al. (2014) [4] were investigated the coconut as partial replacement of coarse aggregate in concrete. The aim of this research is to spread awareness of using coconut shell partial replacement of coarse aggregate in concrete and determining its compressive strength and density. The conclusions for the research are the compressive strength of concrete decreased as the percentage shell substitution increased. Also increase in percentage replacement by coconut shell increase workability of concrete. Coconut shell can be used as partial replacement of coarse aggregate in R.C.C concrete.

Akshay S. Shelke et al (2014) [5] in this investigation, coconut shell is used and the result find that coconut shell concrete increase the speed of construction, enhance green construction environment we can use lightweight concrete. The possibility exists for the partial replacement of coarse aggregate with coconut shell to produce lightweight concrete. Coconut shell exhibits more resistance against crushing, impact and abrasion, compared to crushed granite aggregate. Coconut shell can be grouped under lightweight aggregate.

## III. MATERIALS USED

### *A. Cement*

The Bureau of Indian Standards has graded the Ordinary Portland cement into three grades, namely, 33 grade(IS:269-1989), 43 grade(IS:8112-1989), 53 grade(IS:12269-1987). The compressive strength of these cements at 28 day is at least 33 MPa, 43 MPa, 53 MPa, respectively. Ordinary Portland cement of 43 grade (IS:8112-1989) was used for this project.

### *B. Coarse aggregate*

Coarse aggregate crushed gravel, uncrushed gravel and partially crushed gravel. Coarse aggregate provide strength to the concrete. The aggregate which was locally available crushed blue granite and passing through 20 mm IS sieve is used as a coarse aggregate.

### *C. Fine aggregate*

Fine aggregate are those aggregate which can be pass through 4.75 mm IS-sieve, the residue of the sieve are not considered. Fine aggregate act as filler in concrete, fine aggregate is usually known as sand and it most complies with coarse, medium or fine grading requirement. The sand which was locally available and passing through 4.75 mm IS Sieve is used as fine aggregate**.**

### *D. Water*

Water is an important factor of concrete as it actually participates in the chemical reaction with cement. Also, the water which may be harmful for drinking may be used for mixing and curing as the impurities may not affect the quality of concrete. Therefore it is necessary to that the water used is not polluted or contain any substance that may affect the reaction between the two components, so tap water will be used in this study.

### *E. Coconut shell*

For the purpose of this research, the Coconut shells were obtained from a local coconut shops, temples and other filed located in Sardulgarh and Sirsa. They were sun dried for 2 week approximately at the temperature of 25 to 30 removed fiber and husk on dried shells; further broken the shells into small chips manually using hammer and sieved through 20 mm sieve. The material passed through 20 mm sieve was used to replace coarse aggregate with CS. The material retained on 20 mm sieve was discarded.

### *F. Fly ash*

Fly ash is a fine powder which is a byproduct from burning pulverized coal in electric generation power plants. Fly ash

  

can be an expensive replacement for Portland cement in concrete although using it improves strength, segregation and ease of pumping concrete. For this research, fly ash is used to replace the cement from concrete. For the purpose of this research, the fly ash was obtained from a thermal power plant located in bathinda where electricity is produce from burning of coal. Class C type of fly ash was used for this work.

## IV. PREPARATION OF SPECIMEN

The study is conducted to analyze the compressive strength and workability of concrete when the natural coarse aggregate is partially replaced with waste coconut shell and when the cement is partially replaced with fly ash respectively. Compressive strength tests were done on compression testing machine using 150mm X 150mm X 150mm cube samples. The workability of concrete is also tested by slump test method. Three samples per batch were tested with the average strength values reported in this paper. In order to investigate properties of coconut shells concretes, five mixes were employed. Control mix (M1) that is, without coconut shells was made. Coarse aggregate was then replaced with coconut shells in 10 (M2), 20 (M3), percentages to study effect of CS replacement. Furthermore, a mix with both coconut shells and fly ash (M4) was also employed, in which, 10% of coconut shells was replaced with coarse aggregate and 10% of fly ash was replaced with fine aggregate. M5 mix contained 20% of coconut shells and 20% of fly ash both replaced with coarse and fine aggregate. In all total 45 cubes were examined for compressive strength test result were analyzed after curing of 7 days, 14days, and 28 days. Results obtained from the replacement are compared with data from a conventional concrete.

## V. EXPERIMENTAL PROGRAMMER

Result of the slump test (workability)

Table 1: Slump value of coconut shell and fly ash concrete

| Sr. | Mix (%) | Average Slump value (mm) |
|---|---|---|
| 1. | M 1 (0%) | 60 |
| 2. | M 2 (10%) | 50 |
| 3. | M 3 (20%) | 45 |
| 4. | M 4 (10% CS with CA + 10% Fly ash with fine aggregate) | 65 |
| 5. | M 5 (20% CS with CA + 20% Fly ash with Fine aggregate) | 75 |

*5.1.1 Effect of coconut shell and fly ash on workability*

The coconut shell has low slump, the slump value of the coconut shell concrete were 50mm and 45 mm. The slump decrease with decrease in value when the percentage of coconut shell was increase. For M 1 mix, in which, no any replacement of materials and the value of slump is 60 mm. For the M 2 and M 3 mix, in which replacement of coarse aggregate with coconut shell is 10% and 20%, in this replacement the value of slump decrease by decrease. However, for M 4 mix, in which the fine aggregate was, replaced with 10% fly ash and 10%coconut shell with aggregate shown better performance compare to M 2 and M 3. Further, for M 5, in which the aggregate was replaced with 20% coconut shell and 20% fly ash with fine aggregate had shown highest performance. These observations suggest that addition of CS decrease workability and addition of fly ash increase workability in coconut shell concrete. The decreased workability of CS concretes may be due to CS particle shape. Flat shaped CS particles could have restricted overall movement of the aggregate particles and thus reduced workability. Therefore, it can be concluded that as the fly ash content increases in a concrete mix, the water demand is reduced. The fineness and spherical shape of fly ash particles are the main physical properties that play a major role in improving the workability of a concrete mix. So that 20% coconut shells with 20% fly ash are the best ratios for the replacement of coarse and fine aggregate.

*5.2 Compressive strength*

Compressive strength of concrete mixes made with different ratios of coconut shell and fly ash as replacement of coarse aggregate, cement and fine aggregate were determined at 7, 14 and 28 days of curing. The test results are given in tables and shown in figures

Table 3: Compressive strength result

| Compressive strength (MPa) | | | | |
|---|---|---|---|---|
| Sr. | Specimen | 7 days | 14 days | 28 days |
| 1. | M 1 (0%) | 22.92 | 28.66 | 38.22 |
| 2. | M 2 (10%) | 22.38 | 27.97 | 37.30 |
| 3. | M 3 (20%) | 20.70 | 25.87 | 34.50 |
| 4. | M 4 (10% CS with Coarse aggregate+10% Fly ash with fine aggregate) | 22.50 | 28.12 | 37.50 |
| 5. | M 5 (20% CS with Coarse aggregate + 20% Fly ash with fine aggregate) | 23.22 | 29.02 | 38.70 |

*5.2.1 Discussion*

Above, in Table22 shows the compressive strengths of all the concretes for 7, 14 and 28 days of curing. The strength of all the concretes increased with curing age. Concrete gained 60 percent and 75 percent over its 28 days strength at 7 day and 14 day of curing respectively. Strength of the CS concretes increased 70 percent at 7 day and 80 percent after 14 days of curing than its corresponding 28 day strengths respectively.

  

This observation suggests that as CS percentage increased the 7 day strength gain also increased with corresponding 28 day curing strength. The CS concretes, especially 10 % (M2) and 20% (M3) replacement level the concretes failed to maintain same strength gain, which had first 7 days of curing. This may be due to lack of sufficient bond between the particles. As the first 7 days of curing, majority of the compressive strength of the concretes depends on paste strength. However, at later age, the strength of concrete depends on strength of the paste, strength of the aggregate and bond strength between the aggregate particles and cement paste. In the other replacement we used fly ash to increase the strength of the concrete. In the M 4 mix, replacement of 10% coarse aggregate with coconut shell with addition of fly ash (10%) to replace fine aggregate gives the better result as compared to M1 and M2.However, when we used 20% fly ash to replace fine aggregate gives the better result compare to conventional concrete. Due to binding properties of fly ash, increase the strength of concrete. It is also clear that as the percentage of sand replacement by fly ash and percentage of coarse aggregate by coconut shell in a concrete mix increases between 0 to 20 % the compressive strength increases. On the other hand, increase in strength is attributed to the pozzolanic action of fly ash. The fly ash reacts slowly with calcium hydroxide liberated during hydration of cement, this chemical reaction keeps reacting for long time and due to this reaction the compressive strength keeps increasing with age. So that the fly ash is the best material to replace fine aggregate due to increase strength by age. 20% fly ash and 20% coconut shell is considered to be the best ratio of fine aggregate replacement in a concrete mix.

## VI. CONCLUSION

In this study, we replaced coarse aggregate with coconut shell. Specimens were cast by replacing coarse and cement in different three case. First case, 10% and 20% of coarse aggregate replacing with coconut shell and in second case, 10% of coarse aggregate replacing with coconut shell and 10% of fine aggregate replacing with fly ash. In third case, 10% of coarse aggregate replacing with coconut shell and 20% of fine aggregate replacing with fly ash. Tests were conducted on the cast specimens after 7 days, 14 days, 28 days as mentioned in the IS code. Tests for workability, flexure and compression strength were conducted and results were obtained.

The main points of this study are:

- Addition of coconut shells decreases workability and addition of fly ash either as fine aggregate replacement or aggregate replacement increase workability of coconut shells concrete. Increase in coconut shells percentage decrease densities of concrete.
- With coconut shells percentage increase the 7 days strength gain also increase with corresponding 28 days curing strength. So the strength of coconut shells concrete increase due to increase curing in accurate days.
- By replacement of coconut shell in place of aggregate, 10% and 20% replacement will have been decrease marginally the strength properties of concrete compared to the normal concrete.
- But in case of replacement of coconut shells in place of aggregate and replacement of fly ash in place of fine aggregate will increase the strength properties of concrete compared to the replacement 10% and 20% with coconut shell.
- Having fly ash in a concrete mix as a replacement of cement fine aggregate increases its compressive strength due to the pozzolanic activity of the ash.
- The compressive strength of a fly ash concrete keeps increasing over a long time because the fly ash retards the hydration process of cement, whereas ordinary concrete reaches its maximum compressive strength after around 28 days.
- 10% FA as replacement of fine aggregate has achieved the maximum compressive strength compared to coconut shell.
- 20% FA as replacement of fine aggregate has achieved the maximum compressive strength.
- In case of split test, strength of concrete same as compressive test decrease in the replacement of 10% and 20% with coconut shell. But the strength increase by use of fly as ash as a fine aggregate.
- So that fly ash with combination of coconut shell is the best option to reduce the cost of construction and also reduce the weight of concrete. These concrete also used as a light weight concrete which easily to construct.

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