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Experimental Analysis for Determination of the Optimum Use of Natural and Artificial Waste Material in Concrete

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Abstract – The concrete is most important civil engineering construction material. Concrete consist of various ingredients like Cement, Coarse aggregate and Fine aggregate with w/c ratio 0.46 in proportion. Cement acts as binding material & now a day's partly replaced with fly ash. Fly ash is a waste product of power plants. The disposal of fly ash is big problem now a day. An experimental analysis is proposed to replace cement & aggregate by the artificial and natural waste product like fly ash and coconut shell in different proportion. Coconut shell is hard and light weight material. The properties of coconut shell and aggregate is examined and the suitability of coconut shell aggregate in construction is also examined. The main objective is to analyse the usefulness of fly ash, coconut shell and glass as a construction material and to prepare lightweight concrete by using coconut shell as coarse aggregate. The experimental study is carried out on strength characteristics of M30 concrete with replacement of 10% & 20% of cement, coarse aggregate and fine aggregate by fly ash, coconut shell and glass. The water cement ratio is 0.46 by using compressive, tensile strength of concrete at, 03,07 & 28 days are determined with experimental analysis and the results are compared with conventional concrete.

Key Words – Fly Ash, Coconut shell, Glass, Compressive, Strength, Tensile strength, waste material

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I. INTRODUCTION

The demand for material has been continuously rising with the increasing need for housing both in rural and urban areas. The resource used to manufacture construction materials affect the environment by depleting natural resources, using energy, and releasing pollutants on the land and water .Commercial exploitation of traditional building materials by various industries has aggravated the situation. It has, therefore, become necessary to think over this problem seriously and to provide some sustainable solution to make the alternative materials available to solve the housing problem. With consideration of these points, the effective use of alternative material for conventional concrete ingredients are studied.

Coconut Shell: Coconut shell is found throughout the tropic and sub-tropic area.. Coconut trees are located among the most common sights throughout the coastal areas like Kerala. Various southern states combined account for almost 92% of the total production in the country: Kerala (45.22%), Tamil Nadu (26.56%), Karnataka (10.85%), and Andhra Pradesh (8.93%). Other states, such as Goa, Maharashtra, Odisha, West Bengal, and those in the northeast (Tripura and Assam) account for the remaining 8.44%.India produces a 10,824,100 tones/year of Coconut.

Glass: Glass is mixture of number of metallic silicates. It is one of the most versatile and oldest materials in the building industry. From its humble beginnings as a window pane in luxury houses of Pompeii to sophisticated structural members in new age buildings, its role in architecture has evolved over the years.

Engineering Properties of Glass

1. Transparency
2. Strength
3. Workability
4. Transmittance
5. Recycle property

Fly ash : Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of power generation facilities, whereas bottom ash is, as the name suggests, removed from the bottom of the furnace. In the past, fly ash was generally released into the atmosphere

via the smoke stack, but pollution control equipment mandated in recent decades now require that it be captured prior to release. It is generally stored on site at most US electric power generation facilities. Depending upon the source and makeup of the coal being burned, the components of the fly ash produced vary considerably, but all fly ash includes substantial amounts of silica (silicon dioxide, SiO_2) (both amorphous and crystalline) and lime (calcium oxide, CaO). Fly ash is commonly used to supplement Portland cement in concrete production, where it can bring both technological and economic benefits, and is increasingly finding use in synthesis of geopolymers and zeolites.

II. LITERATURE REVIEW:

1) Gunasekaran, P.S. Kumar, M. Lakshmipathy (2011). "*Mechanical and bond properties of coconut shell concrete,* Elsevier Construction and Building Materials 25, pp. 92–98

Findings: Authors founds that the properties of concrete using coconut shell as coarse aggregate. Compressive, flexural, splitting tensile strengths, impact resistance and bond strength were measured and compared with the theoretical values as recommended by the standards. For the selected mix, two different water–cement ratios have been considered to study the effect on the flexural and splitting tensile strengths and impact resistance of coconut shell concrete. The bond properties were determined through pull-out test. Coconut shell concrete can be classified under structural lightweight concrete.

2) S.P. Gautam, Vikas Srivastava and V.C. Agarwal (2012). "Use of glass wastes as fine aggregate in Concrete" *J. Acad. Indus. Res.* Vol. 1(6), pp. 320-323

Findings: Author conducted laboratory experiments to explore the use of waste glass as coarse and fine aggregates for both ASR (Alkali-Silica-Reaction) alleviation as well as the decorative purpose in concrete. The study indicated that waste glass can effectively be used as fine aggregate replacement (up to40%) without substantial change in strength.

3) Vinod Goud and Niraj Soni (2016). "Partial Replacement of Cement with Fly Ash in Concrete and its Effects" IOSRJEN – ISOR Journal of Engineering | Volume 06 | Issue 10 | Oct 2016

Findings: In this paper the study was made on M25grade of concrete for 0.35 w/c ratio. The effect of different w/c ratio was studied. Replacement of 10%,20%,&30% of fly ash as cement for 7 & 28 days curing. The replacement 10%&20% of fly ash shows good compressive strength for 28 days and 30% replacement shows decrease in compressive strength.

III. OBJECTIVE

Following are the objectives of the research:

1) To study the properties of Coconut shell, Glass and Fly Ash.

2) To study the properties of concrete ingredient (Standard Concrete For M 30 Grade)

3) Comparative Study between conventional concrete and coconut shell and glass base concrete with the following Tests (For M 30 Grade of Concrete)

   i) Compression Strength

   ii) Tensile Test

IV. PROBLEM STATEMENT & METHODOLOGY

Problem Statement: Now a day's construction of infrastructure and housing increases rapidly in our country. Due to this consumption of cement, coarse aggregate and fine aggregate increases day by day, for manufacturing of these ingredents requires the natural recourses so due to this large amount of utilization natural recourses environmental imbalance takes place, due to this need of alternative materials essentially require to partially replacement of these ingredients. The effective use of natural and artificial waste can be best alternative for cement, coarse and fine aggregate.

Methodology: For this research, the following flow of work followed –

Step 1- Collection of Fly ash, coconut shell and glass from the adjoining industry

Step 2- The analysis of fly ash, coconut shell and glass is carried out, to identify the physical and engineering properties of fly ash, coconut shell and glass.

Step 3: In this experimental work Fly Ash, coconut shell and glass with different proportion (10 %, 20%) added to concrete mix design for M 30 of concrete and different elements like a cube, cylinders, are casted.

Step 4- Experimental work is carried out on cast elements and test results are compared with conventional concrete.

Experimental Details: -

The ingredients of concrete i.e. cement, fine aggregate, coarse aggregate, Fly Ash, glass powder, coconut shells are tested before producing concrete. The respective Indian standard codes are followed

for conducting various tests on ingredients materials of the concrete.

The raw materials used in this experimental work locally available and these included Ordinary Portland Cement (O.P.C) as binding agent, waste glass sand as fine aggregate and coconut shell as coarse aggregate flay ash as cement. Potable tap water was used for mixing and curing throughout the entire casting. The permissible and tolerance limits of water were checked as per the I.S 456-2000.

Test of properties of different materials

Cement:- Ordinary Portland cement grade 43, conforming to I.S 12269-2009 was used.

Table No 1: Properties of Cement

Sr. No.	Physical Property	Test Result
1	Standard Consistency	36%
2	Fineness	4.6%
3	Soundness	1mm
4	Initial Setting Time	50 min
5	Final Setting Time	563 min

Fly Ash: Following result obtained from fly ash testing in laboratory which is collected Industry.

Table No 2: Properties of Fly Ash

Sr. No.	Property	Value
1	Specific Gravity	2.3
2	Moisture Content	19.75
3	Fineness	0.001-0.6 mm
4	Soundness	0.15 %

Coarse Aggregate And Coconut Shell:-

Coarse aggregate consists of 50% of self-weight of concrete and 70% of volume of concrete. Coconut shells are collected from temples to analyse the properties of coconut shell (2-7 mm thickness.

Table No 3: Properties of Coarse Aggregate and Coconut Shell

Sr. No.	Properties	CA	CS
1	Specific Gravity	2.92	2.38
2	Bulk Density	1650	1190
3	Water Absorption (%)	0.65	0.47
4	Fineness Modulus	6.90	6.00
5	Impact Value	7.50	35.42

Glass powder : Waste glass for this experiment was sourced from a glass recycling company" Pitroda Pulverizing & Engg Works" Bhavani Peth Pune. The company collects mixed colour post-consumer container glass, material to a crushing and milling process in order to create a fine aggregate.

Table No 4: Properties of Coarse Aggregate And Coconut Shell

Sr. No.	Properties	FA	GS
1	Specific Gravity	2.56	2.38
2	Fineness Modulus(%)	3.48	3.48
3	Water Absorption (%)	0.37	0.14

Casting of Sample:

1. For the determination of compressive strength of concrete the mould of size 150x150x150 mm for M30grade of concrete are used It is cured for 3,7& 28 days.

2. For the determination of split tensile strength of concrete the specimen are casted of size 150mm dia.&300 mm ht. for M30grade of concrete are used It is cured for 3,7& 28 days.

3. The necessary precations were taken during casting after 24 hrs all the specimens are demoulded & curing was done under standard conditions.

V. RESULTS:

Compressive Strength

As per IS 516:1959, test specimens of size 150x150x150 mm were prepared for testing the compressive strength concrete. Fly Ash, coconut shell and glass with different proportion (10 %, 20%) added to concrete mix design for M 30 and different elements like a cube, cylinders, are casted.

The rate of applied loading should be 140 kg/ cm^2 per minute. In this study, to make concrete, cement and fine aggregate are first mixed dry to uniform colour and then coarse aggregate was added and mixed with the mixture of cement and fine aggregates. Water was then added and the whole mass mixed.

The interior surface of the moulds and the base plate were oiled before concrete was placed. After 24 hours the specimens are removed from the moulds and placed in clean fresh water at a temperature of 27ºC. The specimens casted are tested after 3 days, 7 days and 28 days after curing. For testing in compression, no cushioning material was placed between the specimen and the plates of the machine. The load was applied axially without shock

till the specimen was crushed. Results of the compressive strength test on concrete are as follow:

Split Tensile Strength

Concrete is sufficient in strength only in one direction. The tensile strength of concrete is approximately one-tenth of the compressive strength and it is not generally used in the design of concrete structure. Nevertheless, it is an important property in many applications. The splitting indirect tensile is also known as the Brazil test, which developed originally in Brazil. The testing of specimens in pure tension is very difficult and usually determines by indirect mean, applying tension in the form of splitting. Concrete specimens for indirect tensile test were 150mm diameter and 300mm height. The specimens were placed with its axis horizontal, between the platens of a compression- testing machine. Load was applied until the specimen fails in its vertical diameter. The splitting test is simple to conduct and gives more consistent results than other tension tests. It is believed that the strength obtained by splitting test is near to that of the true tensile strength of the concrete than modulus of rupture. Tensile strength of a concrete is a measure of its ability to resist forces, which stretch or bend it. Unlike steel, the concrete is sufficient in strength only in one direction. The tensile strength of concrete is approximately one-tenth of the compressive strength and it is not generally used in the design of concrete structure. Nevertheless, it is an important property in many applications. The splitting indirect tensile is also known as the Brazil test, which developed originally in Brazil. The testing of specimens in pure tension is very difficult and usually determines by indirect mean, applying tension in the form of splitting. Concrete specimens for indirect tensile test were 150mm diameter and 300mm height. The specimens were placed with its axis horizontal, between the platens of a compression- testing machine. Load was applied until the specimen fails in its vertical diameter. The splitting test is simple to conduct and gives more consistent results than other tension tests. It is believed that the strength obtained by splitting test is near to that of the true tensile strength of the concrete than modulus of rupture.

The load shall be applied as per IS. 5816-1999 (reaffirmed 2004) without shock and increased continuously at a nominal rate within the range 1.2 N/ (mm^2/min) to 2.4 N/ (mm^2/min).Maintain the rate, once adjusted, until failure. On manually controlled machines as failure is approached the loading rate will decrease; at this stage the controls shall be operated to maintain as far as possible the specified loading rate. The maximum load applied shall then be recorded. The appearance of concrete and any unusual features in the type of failure shall also be noted.

Tensile strength of a concrete is a measure of its ability to resist forces, which stretch or bend it. Unlike steel, the concrete is sufficient in strength only in one direction. The tensile strength of concrete is approximately one-tenth of the compressive strength and it is not generally used in design of concrete structure. Nevertheless, it is an important property in many applications

CONVENTIONAL CONCRETE TEST RESULTS

Table No 5: Result of Conventional Concrete

Sr. No.	Compressive Strength, MPa			Split Tensile Strength, MPa		
Days	3	7	28	3	7	28
1	15.1	23.4	37.3	1.7	2.5	3.7
2	14.7	24.2	38.1	1.74	2.52	3.6
3	14.9	23.9	37.1	1.79	2.9	3.7

Table No 6: 10% Replacement of cs as coarse aggregate 10% Replacement of cs as coarse aggregate

Sr. No.	Compressive Strength, MPa			Split Tensile Strength, MPa		
Days	3	7	28	3	7	28
1	16.6	26.67	36.7	1.45	2.31	3.6
2	16.83	27.43	37.0	1.40	2.2	3.5
3	17.10	27.14	36.8	1.43	2.27	3.4

Table No 7: 20% REPLACEMENT OF CS AS COARSE AGGREGATE 20% REPLACEMENT OF CS AS COARSE AGGREGATE

Sr. No.	Compressive Strength, Mpa			Split Tensile Strength, MPa		
Days	3	7	28	3	7	28
1	17.34	25.01	34.7	1.32	1.96	3.5
2	18.02	25.42	34.9	1.28	1.98	3.2
3	18.47	24.78	32.8	1.33	2.34	3.3

Table No 8: 10% COCONUT SHELL AGGREGATE + 10% FLY ASH + 10% GLASS REPLACEMENT 10% COCONUT SHELL AGGREGATE + 10% FLY ASH + 10% GLASS REPLACEMENT

Sr. No	Compressive Strength, Mpa			Split Tensile Strength, MPa		
Days	3	7	28	3	7	28
1	17.34	24.7	37.3	1.8	2.6	3.7
2	17.89	24.98	37.9	1.82	2.8	3.8
3	18.53	24.6	37.5	1.89	2.67	3.85

Table No 9: 10% COCONUT SHELL AGGREGATE + 20% FLY ASH + 20% GLASS REPLACEMENT 10% COCONUT SHELL AGGREGATE + 20% FLY ASH + 20% GLASS REPLACEMENT

Sr. No.	Compressive			Split Tensile		
Days	3	7	28	3	7	28
1	17.92	24.2	37.7	1.78	2.5	3.76
2	17.84	24.6	38.0	1.76	2.4	3.5
3	17.81	24.33	37.6	1.76	2.6	3.72

M 30 Grade Concrete:

COMPARISON OF RESULTS: (COMPRESSIVE STERNGTH)

Table No 10: COMPARISON OF RESULTS

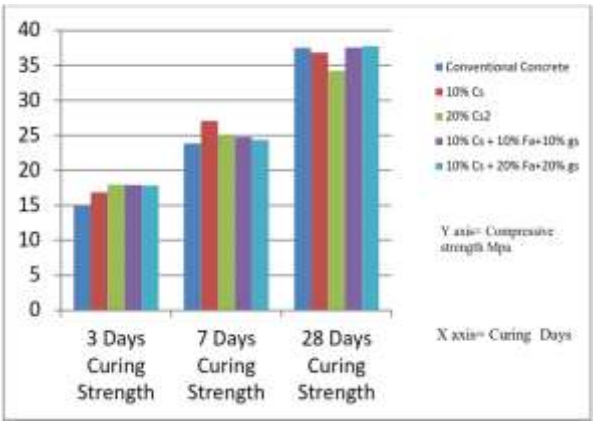
Days	Conventional Concrete Mpa	10% Cs Mpa	20% Cs Mpa	10% Cs + 10% Fa+10% gs Mpa	10% Cs + 20% Fa+20%gs Mpa
3 Day	14.9	16.84	17.94	17.92	17.85
7 Days	23.83	27.08	25.07	24.76	24.37
28 Days	37.5	36.83	34.2	37.56	37.76

COMPARISON OF RESULTS: (SPLIT TENSILE STRENGTH)

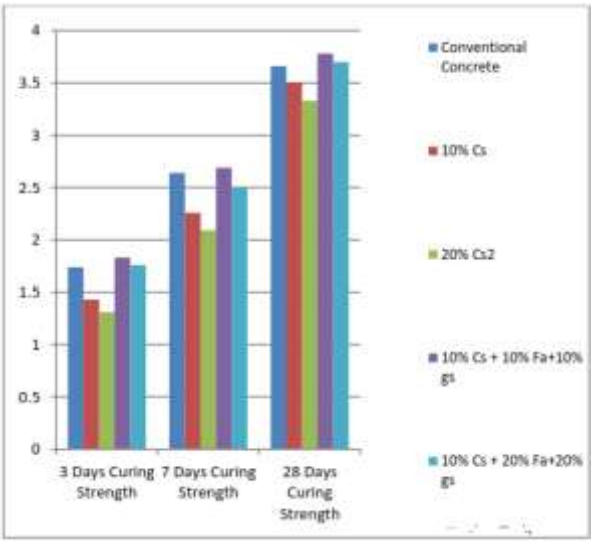
Table No 11: COMPARISON OF RESULTS:

Days	Conventional Concrete Mpa	10% Cs Mpa	20% Cs Mpa	10% Cs + 10% Flyash+10%gs Mpa	10% Cs + 20% Flyash+20%gs Mpa
3 Day	1.74	1.43	1.31	1.83	1.76
7 Days	2.64	2.26	2.09	2.69	2.5
28 Days	3.66	3.5	3.33	3.78	3.7

Graphs:



Graph No. 1: Comparison Between Conventional Concrete and Modify concrete (Compressive Strength)



Graph No 2: Comparison Between Conventional Concrete and Modify concrete (Split tensile Strength)

VI. CONCLUSION:

Results of experiments on compressive strength, split tensile strength, for the replacement of different percentage of coconut shells concretes are presented with the conventional concrete. However, performance of coconut shells aggregate concrete having a marginal variation than conventional aggregate concrete. The main points of this study are:

1. The partial replacement of coconut shells in place of aggregates, 10% & 20% replacement has decreased marginally the strength properties of concrete compared to the conventional concrete.

2. The partial replacement of coconut shells as coarse aggregates and replacement of fly ash as cement increase the strength properties of concrete compared to the conventional concrete.

3. The replacement of the 10%coconut shells as coarse aggregate decreases the marginal value of 0.67% in compression strength and 0.16% in split tensile strength.

4. The replacement of the 20%coconut shells as coarse aggregate decreases the marginal value of 3.3% in compression strength and 0.33% in split tensile strength.

5. The replacement of the 10%coconut shells as coarse aggregate and 10%fly ash as a cement and 10% glass powder as fine aggragate increases the marginal value of 0.06% in compression strength and increase of 0.12% in split tensile strength.

6. The replacement of the 10%coconut shells as coarse aggregate and 20%fly ash as a cement and 20% glass as fine aggregate increases the marginal value of 0.26% in compression strength and increase of 0.1% in split tensile strength.

7. From the fig no: 1 The compressive strength of concrete increase with increase in percentage of coconut shell percentage.

8. From the fig no:2 The replacement of Coconut shell as Coarse aggregate and Fly ash as Cement and Glass as Fine aggregate increase the compressive strength of concrete.

Photo Gallery:

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