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Determination of Compressive Strength in Concrete Using Banana Fibre as a Additional Reinforcement And Coconut Shell As A Partial Course Aggregate

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ABSTRACT -*The rising cost of construction material is a matter of concern. The reason for increase in cost is high demand of concrete and scarcity of raw material.. Two mixes with coconut shell is partially replaced in concrete. In this study, M 25 grade of concrete was produced by replacing aggregate by coconut shell. Concrete produced by 0%, 10%, 20%, 30% replacement of coarse aggregate by coconut shell.8 cubes were casted and their compressive strength were evaluated at 7, 14 and 28 days. The compressive strength of concrete reduced as the percentage replacement increased. Its utilization is cost effective and ecofriendly. In prospect of this, people have begun researching for suitable other viable alternative materials for concrete so that the existing natural resources could be preserved to the possible extent, for the future generation. Lately, on the environmental issues, restrictions on local & natural access or sources and dispose of waste material are gaining great importance. Aggregate is a major ingredient for making concrete, occupy almost 70-80% part of concrete. The roles of structural grade lightweight concrete reduce considerably the self-load of a structure and permit larger precast units to be managed. The waste coconut shell may be utilized to replace coarse aggregate.*
Banana fibers are environmentally friendly and present important attributes, such as low density, light weight, low cost, high tensile strength, as well as being water resistant. This kind of waste has a greater chance of being utilized for different application in construction and building materials. NAoH is added to the fibre in order to increase the strength and water non-absorbent.
KEYWORDS: *compressive strength of concrete, coconut shell, Banana fiber,NAoH, coarse aggregate.*

I. INTRODUCTION

The demand for low cost sustainable building materials is growing as social, economic, and environmental issues evolve in today's society. The urgent need to develop suitable and affordable housing is born as a consequence of the fact that over one billion people in the world, most of whom live in developing nations, are either homeless or live in very poor housing. Affordable housing for all income levels is an ever-present need. High material, labor and transportation costs have adversely affected the ability for some to reside even in developing communities. Natural building materials offer a number of environmental benefits, which are typically produced using simple, quick processes without the need for highly skilled labor, with low embodied energy, and by using raw materials from plant waste and construction materials. This study is going to show that these traditional binders can be replaced by

environmentally friendly and sustainable alternatives from unutilized waste (i.e., banana fibers). Over 10 million hectares of Banana plantation, with an average of 1500 plants per hectare, exist in more than 160 countries globally, creating tons of banana waste, which have been left over to decompose, emitting a huge amount of methane gas and carbon dioxide. These emissions have a negative impact on the environment, which increases global warming every year. Every ton of banana waste emits, on average, a half-ton of carbon dioxide per year.

Concrete is a composite material which composed of aggregates, cement and water. Concrete is used more than any other manmade material in the world. The utilization of concrete is increasing at a higher rate due to development in infrastructure and construction activities all around the world. The possibility of a complete depletion of aggregate resources has rendered continued use of aggregates for construction unsustainable. In view of this challenge, researchers throughout the world have been investigating ways of replacing aggregates to make construction sustainable and less expensive. Research addressing environmental and sustainability issues in construction has generated lot of interest in the world. While wastes generated by industrial and agricultural processes have created disposal and management problems which pose serious challenges to efforts towards environmental conservation, their use contributes to resource conservation, environmental protection and the reduction of construction costs. Since waste materials can be obtained at little or no cost, while making significant contribution to the conservation of natural resources and maintenance of ecological balance. Coconut shell is an agricultural waste. It is categorized as light weight aggregate. Coconut shells are by-products of coconut oil production. Cost reduction of 48% can be achieved if the waste utilization can be used in the concrete mixtures. The coconut shell when dried contains cellulose, lignin and ash in varying percentage.

The concrete obtained using Coconut Shell aggregates satisfies the minimum requirements of concrete. Concrete using Coconut Shell aggregates resulted in acceptable strength required for structural concrete. Coconut Shell may offer itself as a coarse aggregate as well as a potential construction material in the field of construction industries and this would solve the environmental problem of reducing the generation of solid wastes simultaneously.

The Coconut Shell- cement composite is compatible and no pre-treatment is required. Coconut Shell concrete has better workability because of the smooth surface on one side of the shells. The impact resistance of Coconut Shell concrete is high when compared with conventional concrete. Moisture retaining and water absorbing capacity of Coconut Shell are more compared to conventional aggregate. The amount of cement content may be more when Coconut Shell are used as an aggregate in the production of concrete compared to conventional aggregate concrete. They are sun dried for 1 month before being crushed manually. Coconut shell is categorized as light weight aggregate. The coconut shell when dried, contains cellulose, lignin, pentosans and ash in varying percentage.Within Asia the construc- tion industry is yet to utilize the advantage of light weight concrete in the construction of high rise structures . Coconut Shell (CS) is not commonly practiced in the construction in- dustry, but are often dumped as agricultural wastes. Until now, Industrial byproducts and domestic wastes have been utilized in concrete, but the utilization of agricultural waste in concrete is in its early childhood phase. Coconut shell is an agricultural waste. The concrete with ground coconut shell was found to be durable in terms of its resistance in water, acidic, alkaline and salty. Coconut shell being a hard and not easily degrade material if crushed to size of sand can be a po- tential material to substitute sand. At present, coconut shell has also been burnt to produce charcoal and activated carbon for food and carbonated drinks and filtering mineral water use.

It is interesting to note that natural fibers such as jute, coir, banana, sisal, etc., are abundantly available in developing countries like India, Sri Lanka, and some of the African countries but are not optimally utilized. At present these fibers are used in a conventional manner for the production of yarns, ropes, mats, and matting as well as in making articles like wall hangings, table mats, handbags, and purses. Fibers such as cotton, banana, and pineapple are also used in making cloth in addition to being used in the paper industry. Many of the plant fibers such as sisal, coir, banana, Palmyra etc. find applications as a resource for industrial materials.

Curing & its importance

controlling the rate and extent of moisture loss from concrete during cement hydration.Curing also control the ambient temperature of hydrating co0ncrete **2 Usage of banana fiber and addition of NaoH**

Banana fibers are environmentally friendly and present important attributes, such as low density, light weight, low cost, high tensile strength, as well as being water resistant. This kind of waste has a greater chance of being utilized for different application in construction and building materials. NaoH is added to the fibre in order to increase the strength and water non absorbent.

Concern on use of portable water curing

Construction industry is one of the major consumers of water resource in the world. The construction of a 100,000 sq.ft multi-storey structure can require about 10 millionlitres of water for production, curing and site development activity. A double lane flyover can consume 70 million litres of water on the same scale.The loss of precious fresh water during pond curing or wastage during intermittent sprinkling 0f water is an area of concern where availability of water is scarce. Researches across the world are engaged in finding methods to reduce the use potable water in construction work,without sacrificing quality. other practical issues related to curing water at construction site.

The quality water resource available for construction is less. cost of obtaining water of desired quality at site is expensive or otherwise disturbing the natural sources like tube well or pond around.Hot weather regions like most part of india where large quantity of water is needed for curing owing to evaporation losses etc.Then also proper internal curing is not achieved.

that is allowed to dry out quickly also undergoes considerable early age drying shrinkage. Inadequate or insufficient curing is one of main factors contributing to weak, powdery surfaces with low abrasion resistence. The durability of concrete is affected by a number of factors including its permeability and absorptivity, result of lack of curing. These are related to the porosity of the concrete and whether the pores and capillaries are discrete or interconnected. Whilst the number and size of the pores and capillaries in cement paste are related directly to its water cement ratio, they are also related indirectly to the extent of water curing.

Long-time water curing cause hydration products to fill the pores and capillaries present either partially or completely in turn to reduce the porosity of the paste. Curing is designed primarily to keep the concrete moist by preventing the loss of moisture from the concrete during the period in which it is gaining strength. Curing must be done for a reasonable period of time if the concrete is to achieve potential strength and durability.

II. PROPERTIES

The materials used for concrete for this study were Portland cement, sand, granite and coconut shells. The raw materials used in this experimentation were locally available and these included Ordinary Portland Cement (O.P.C) as binding agent, river sand as fine aggregate, crushed granite and coconut shell as coarse aggregate. Potable tap water was used for mixing and curing throughout the entire investigation. The permissible and tolerance limits of water were checked as per the IS 456-2000.

Concrete

Concrete is a composite material composed of coarse aggregate bonded together with a fluid cement that hardens over time. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements, such as cement fondu. However, asphalt concrete, which is frequently used for roadsurfaces, is also a type of concrete, where the cement material is bitumen, and polymer concretes are sometimes used where the cementing material is a polymer.

When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and molded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses.[2] Often, additives (such as pozzolans or superplasticizers) are included in the mixture to improve the physical properties of the wet mix or the finished material. Most concrete is poured with reinforcing materials (such as rebar) embedded to provide tensile strength, yielding reinforced concrete.

River sand

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e. a soil containing more than 85% sand-sized particles by mass.

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropicalcoastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz. The second most common type of sand is calcium carbonate, for example aragonite, which has mostly been created, over the past half billion years, by various forms of life, like coral and shellfish. For example, it is the primary form of sand apparent in areas where reefs have dominated the ecosystem for millions of years like the Caribbean. Sand is a non renewable resource over human timescales, and sand suitable for making concrete is in high demand.

Tenacity	29.98 g/denier
Fineness	17.15
Moisture Regain	13.00%
Elongation	6.54
Alco-ben Extractives	1.70%
Total Cellulose	81.80%
Alpha Cellulose	61.50%
Residual Gum	41.90%
Lignin	15.00%

Fig.no.1 Properties of banana fiber

- Appearance of banana fiber is similar to that of bamboo fiber and ramie fiber, but its fineness and spinnability is better than the two.
- The chemical composition of banana fiber is cellulose, hemicellulose, and lignin.
- It is highly strong fiber and It has smaller elongation.
- It has somewhat shiny appearance depending upon the extraction & spinning process.It is light weight.
- It has strong moisture absorption quality. It absorbs as well as releases moisture very fast.
- It is bio- degradable and has no negative effect on environment and thus can be categorized as eco-friendly fiber.Its average fineness is 2400Nm.
- It can be spun through almost all the methods of spinning including ring spinning, open-end spinning, bast fiber spinning, and semi-worsted spinning among others.

Fig.no2 Properties of sodium hydroxide

The following properties are available

- Density
- Specific heat capacity
- Thermal conductivity
- Dynamic viscosity
- Kinematic viscosity
- Coefficient of thermal expansion
- Thermal diffusivity
- Saturation pressure

Pure sodium hydroxide is a whitish solid,solid in pellets,flakes and granular form,as well as in solution.It is highly soluble in water,with a lower solubility in ethanol and methanol,but is insoluble in either and other non polar solvents.

Similar to the hydration of sulfuric acid,dissolution of solid sodium hydroxide in water is a highly exothermic reaction in which a large amount of heat is liberated,posing a threat to safety through the possibility of splashing.The resulting solution is usually colourless and odourless.As with other alkaline solutions,it feels slippery when it comes in contact with skin.

Fig.no.3 Properties of coarse aggregate

The properties of the coarse aggregate used in a concrete mixture affects the modulus for a few reasons. One property is the modulus of elasticity of the coarse aggregate. A higher aggregate modulus will result in a concrete having a higher modulus. As expected, a lightweight aggregate will have a lower modulus than the mortar paste. Conversely, a strong aggregate produces a concrete that is stronger than the mortar paste (Zhou 180). In tests, concrete containing a higher percent of coarse aggregate resulted in a higher elastic modulus. As stated earlier, this is due to the aggregate being stronger than the mortar (Cetin and Carrasquillo 256).

The particle shape of the aggregate contributes to the effectiveness of producing a high performance concrete. Crushed rock creates a much better bond between the paste and the aggregate than a gravel does. However, the aggregate-mortar bond may be more important in flexure tests than in compression tests.

The mineral makeup of the aggregate also influences the modulus of elasticity of concrete. In a study by Aitcin and Mehta, they tested four different types of aggregates: diabase, limestone, gravel, and granite. Their test results showed that the limestone and diabase aggregates gave the highest values for the elastic modulus. The gravel performed poorly because of the weak bond between the aggregate and the cement paste. The granite aggregate, on the other hand, gave the worst results because of its mineral composition. In their granite sample, they found a mineral that is unstable in moist environments which is why the granite specimen's results were poor. Figure 4 shows a sample of a pink granite. Granite has a variety of mineralogical makeups. Therefore, one granite may be much stronger than another.

Properties of coconut shell

Physical properties such as apparent density, bulk density, compressibility index and particle sizes of carbonized and uncarbonized coconut shell nanoparticles produced through top down approach have been studied. Percentage composition of the coconut fruit was determined using five different coconut fruit samples. Results revealed that coir occupies the highest percentage; coconut shells account for 15 % while the flesh and liquid occupy 30 % of the whole coconut fruit. The apparent densities of the uncarbonized and carbonized coconut shell nanoparticles obtained at 70 hours of milling are 0.65 g/cm3 and 0.61 g/cm3 respectively. Their respective compressibility indices and average particle sizes are 46.4 % and 69.7 %; 50.01 nm and 14.29 nm. The difference in the particle sizes of the carbonized and uncarbonized coconut shell nanoparticles can be linked with reduction in the moisture content and volatiles of the carbonized coconut shell nanoparticles due to carbonization process. The reduction in the moisture and volatiles results in the enhanced hardness and brittleness of the carbonized coconut shells which facilitate their breakage during the course of milling than that of the uncarbonized coconut shells.Coconut shell possess outstanding properties. They have high specific modulus which outweighs that of the steel. Their thermal and electrical conductivities are excellent in comparison with those of competing materials such as ceramics and polymers .

a. *Fine Aggregate*

The sand used for the experimental programme was
locally procured and conformed to grading zone III as per IS: 383-1970.The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and then was washed to remove the dust. Properties of the fine aggregate used in the experimental work are tabulated in Table 2.

Specificgravity:	Trail 1	Trail 2	Trail 3
Weight of empty pycnometer (W_1g)	600	600	600
Weight of pycnometer + water (W_2g)	1463	1463	1463
Weight of saturated surface dry (W_3g)	1127	1124	1126
Weight of pycnometer + water + Fine aggregate(W_4g)	1788	1786	1788
Bulk specific gravity= (W3-W1) / [(W2-W1)-(W4-W3)]	2.61	2.60	2.61

Bulk specific gravity = $W_3/(W_3-(W_4-W_2))$ = Average value= 2.61.

Percentage of water absorption = (W_5-W_6/W_6-W_7) X100 = Average value = 0.82%.

Result: specificgravity of aggregateis2.64andpercentageofwaterabsorptionis0.82

Specific gravity

b. Cemen

IS mark 53 grade cement (Brand-Penna cement) was used for all concrete mixes. The cement used was fresh and without any lumps. Testing of cement was done as per IS: 8112-1989. The various tests results conducted on the cement are reported in Table 3.

1.	Weight of empty bottle, W_1 gm	69.8	69.8	69.8
2.	Weight of bottle+ water, W_2 gm	193	190	192
3.	Weight of bottle+ kerosene, W_3 gm	172	171	173
4.	Weight of bottle+ cement+ kerosene, W_4 gm	216.2	215	217.5
5.	Wt of cement, W_5 gm	25	25	25
6.	Sp.gravityofkerosene, $S=(W_3-W_1)/(W_2-W_1)$	0.84	0.84	0.83
7.	Sp.Gravityofcement,$S=W_5(W_3-W_1)/((W_5+W_3-W_4)(W_2-W_1))$	3.15	3.14	3.15
Average specific gravity of cement = 3.15				

Result: specific gravity of cement is 3.15

III. EXPERIMENTAL INVESTIGATION

Mix Ratio: M25 grade of concrete is designed according to IS : 10262 - 2009 method Mix ratio for control mix concrete is shown in Table and different percentage of fibres used is shown in table.

TABLE.3: Water absorbtion

WaterAbsorption:	Trail 1	Trail 2	Trail 3
Weight of tray +saturated surface dry F A (W5)g	1605	1589	1602
Weight of tray + oven dry Fine Aggregate (W6)g	1600	1585	1598
Weight of empty tray	1070	1065	1068
Percentage of water absorption	0.94	0.76	0.75

IV. RESULTSAND DISCUSSIONS

COMPRESSIVESTRENGTHRESULTS

Thetypeofconcrete,ageofconcrete,densityofconcreteandCompressivestrengthsoftheexperimentaretabulatedinthetablegivenbelow.

Compressive test is a very significant test to know mechanical property of concrete. This test is conducted for various percentage of coconut is replaced to the coarse aggregate.

Table:4.1TABULATIONOFCOMPRESSIVESTRENGTHRESULTS

s.no	**TYPEOF DESIGN**	**Cement Inkg/m^3**	**Fine aggregate inkg/m^3**	**Coarse Aggregteinkg/m^3**	**Water Inml**	**Avg. Compressivekg/m^3**
1	**Normalconcrete.**	1.8	1.8	3600	850	3.5
2	**30%coconut shell and 50gms of banana fiber.**	1.8	1.8	1080	850	3
3	**20%coconut Shell and 40gms of banana fiber**	1.8	1.8	720	800	3.3
4	**10%coconut shell and 30gms of banana fiber+addition of NAOH**	1.8	1.8	360	800	3.6

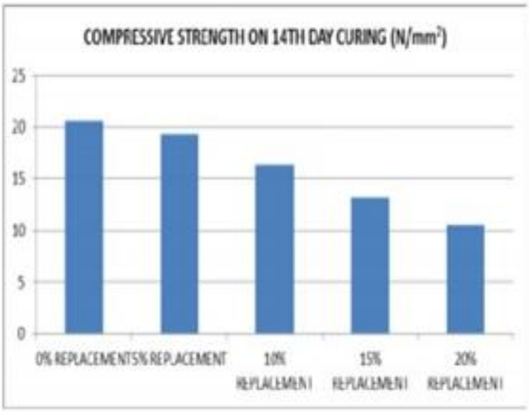
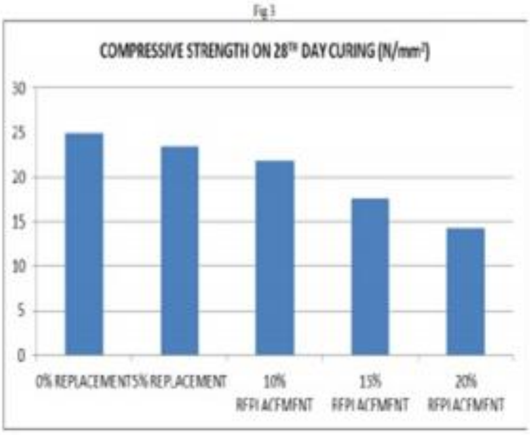
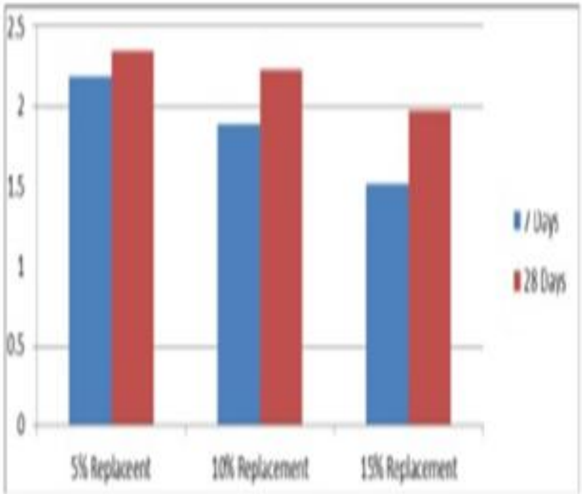


Fig 3





Comparison of compressive strength test

TABULATION OF TENSILE STRENGTHRESULTS
Mixproportion:1:1:2

tensilestrength is one of the important criteria for finding the mechanical property of concrete.
Tensile strength is maximum upto30% high strength concrete.

s.no	**Typeof Design**	**Cement Inkg/m^3**	**Fine Aggregrateinkg/ m^3**	**Coarse Aggregate Inkg/m^3**	**Waterinml**	**Avg.Tensile StrengthKg/ m^3**
1	**Normalconcrete.**	1.8	1.8	3600	850	3.5
2	**30%coconut shell and 50gms of banana fiber.**	1.8	1.8	1080	850	4
3	**20%coconut Shell and 40gms of banana fiber**	1.8	1.8	720	800	3.8
4	**10%coconut shell and 30gms of banana fiber+addition of NAOH**	1.8	1.8	360	800	4.3

V. CONCLUSION

- Increase in percentage replacements by coconut shells reduced the strength and density of concrete.
- The challenge in making a lightweight concrete is decreasing the density while maintaining strength and without adversely affecting cost.
- The coconut shell as aggregate in concrete can reduce the material cost in construction because of the low cost and its availability is abundance.
- Addition of NaoH can make the banana fiber to become more strengthen and water non-absorbent.
- Usage of banana fiber up to 30% will increase tensile strength and compressive strength.

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