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Experimental Investigation of Concrete using GGBS and Coconut Shell with Alcofine to Enhance Concrete Properties

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ABSTRACT

Concrete is the most widely used construction material in civil engineering because of its high structural strength and stability. Concrete is the premier construction material around the world and is most widely used in all types of construction works, including infrastructure, low and high-rise buildings, and domestic developments. It is a man-made product, essentially consisting of a mixture of cement, aggregates, water and admixture(s). Inert granular materials such as sand, crushed stone or gravel form the major part of the aggregates. Traditionally aggregates have been readily available at economic prices and of qualities to suit all purposes. But, the continued extensive extraction use of aggregates from natural resources has been questioned because of the depletion of quality primary aggregates and greater awareness of environmental protection. To find a suitable and effective material from the waste product that would considerably minimize the use of material and ultimately reduce the construction cost. In this project GLASS FIBER and Coconut shell were used as replacement of cement and coarse aggregate respectively. First physical properties of materials were found out and then the properties of GLASS FIBER and coconut shells were also found out. In this project, experimental investigations were carried to find out the workability and strength, Durability characteristics of M20 Grade concrete with different replacement level of cement as (i.e.,5%,10%,15%,20 %) by coconut shell, 0.5% by fiber and 2% alcofine.

Keyword: GLASS FIBER, Coconut shell, Workability, Mechanical Property, Durability Property.

Introduction:

Environmental sustainability may be interpreted as the ability to indefinitely retain the rates of renewable resource use and non-renewable resource depletion. ‘Sustainability’ is one of the most discussed but least understood words in the world. For most nations, organisations and people who consider its importance, sustainability means the conservation of the Earth and basic issues related to improvement, such as the productive utilisation of resources, stable economic growth, consistent social advance and poverty elimination. Sustainable construction aims to meet current requirements for housing, working environment and infrastructure without compromising the capacity of future generations to meet their own needs. Environmental sustainability can be achieved in this sector by replacing conventional aggregates in concrete with solid waste aggregates. Coarse and fine aggregates account approximately 60%–80% of concrete volume. But, the main problem that undermines the use of natural coarse aggregates is sustainability, as it leads to other ecological problems. According to the Ministry of Agriculture and Farmer’s Welfare of India, more than 23900 million coconut nuts have been produced in India in 2016–2017 and this will simultaneously increase the agriculture solid waste accumulation.

Hence, the effective utilisation of agro-wastes, as replacement for traditional aggregates, contributes to the conservation of non-renewable resources, reduces energy consumption and lowers the costs of building materials. Researchers have already used several waste materials in concrete, including recycled concrete, silica fume, ground-granulated blast-furnace slag, fly ash, waste tyre rubber, post-consumer glass and waste plastics. Similarly, coconut shell (CS), palm kernel shell, oil palm shell (OPS), rice husk, corn cob, pistachio shell, spent mushroom substrate and tobacco wastes are waste materials used to produce lightweight aggregate concrete (LWAC). Hence, environmental protection can be achieved through the proper disposal of such solid agro-wastes.

Explains a literature review on LWC and fibre reinforced lightweight concrete. The wastes used in concrete as ingredients in concrete such as coconut shell, palm shell, palm kernel shell, fly ash, GLASS FIBER, textile waste, used engine oil, automotive shredder residue, ceramic waste, waste PET bottles, tire rubber waste, marble quarry waste, guar and tamarind, waste glass and rubber particles, ground clay brick, recycled aggregate, carpet fibre, and mineral powder. This section also presents a review on fibre reinforced LWC concrete. The properties discussed are general characteristics, compatibility, mix design, mechanical properties, structural bond properties, durability performance, flexural and shear behaviour of reinforced beams and temperature resistance performance.

Ahmed Towheed Molvi and Sandeep Singh (2023) the primary objective of the research was to match the results produced by using filler such as fly ash with coconut shell charcoal ash in bituminous concrete. Marshall stability test stability, flow value, VMA and void ratio was performed.

The Marshall stability increases with the increase of filler in the Marshall cake. The flow value increases with the increase of coconut shell charcoal as a filler and decreases the void ratio and VMA with the increase of filler. The different percentage of coconut shell charcoal ash are 1%, 1.5%, 2%, 2.5% and 3% are used in test with 5.5% bitumen. Results stated that coconut shell charcoal ash as a filler may be utilized because of its filler properties since it meets all of the requirements. Coconut shell charcoal as a filler in roads is durable and also less cost.

S. Prajapati and K.S Tirpude (2022) in the research paper, M20 grade of concrete was prepared by using coconut shell as coarse aggregate. Experimental work coarse aggregate was replaced by 5%, 10%, 15%, 20%, 25%, 30% and 35% of coconut shell.

Variation of compressive strength after 28 days with the replacement percentage of coconut shell aggregate was between 5- 15%. It shows that the compressive strength value was approximately near to the target mean strength value of M20 grade of concrete. The compressive strength varies from 25 to 21 N/mm2 for 0% to 35% replacement of coarse aggregate with coconut shell aggregate. The split tensile strength value was near to target mean strength value when percentage replacement of coarse aggregate as coconut shell aggregate is between 5-15%. The split tensile strength varies from 2.80 to 2.42 N/mm2 for 0% to 35% replacement of coarse aggregate as coconut shell aggregate. The flexural strength varies from 3.15 to 3.30 N/mm2 for 0% to 35% replacement of coarse aggregate with coconut shell aggregate. Experiment shows that flexural strength value was near to target mean strength value when the replacement percentage is between 5-15%. According to test after 15% replacement of coarse aggregate by coconut shell aggregate the strength value of concrete is decreased.

OJECTIVES OF THE STUDY:

- To study the effect of coconut shells in concrete and its benefits.
- To study the effect of Ground Granulated Blast-furnace Slag) in concrete and its benefits.
- To approach the use of an alternative material as concrete aggregate.

Table 1 Properties of Coconut Shell

Physical and mechanical properties		
Maximum size (mm)		
Moisture content (%)		
Water absorption (24 hrs.) (%)		
Specific gravity	SSD*	1.06
		-1.18
	Apparent	1.3
		-1.45
Impact value (%)		8.2
Crushing value (%)		2.2
Abrasion value (%)		1.6
Bulk Density (kg / m3)	Compacted	650
	Loose	550
Voids (%)	Compacted	38.1
	Loose	47.7
Fineness modulus		6.32
Shell thickness (mm)		2 - 8

* Saturated Surface Dry

Concrete Pouring and Compaction

- After the mixture is prepared, it is poured into the oiled mould in layers approximately 5 cm deep.
- Then, each layer is compacted either by hand or by vibration.
- For manual compaction, use tamping bar.
- Distributed bar stroke uniformly in order to compact it properly.
- Minimum tamping bar stroke for each layer is 30.
- Penetrate strikes in to the underlying layer
- Apply the rode for the entire depth of bottom layer
- complete top layer compaction
- Lastly, the surface of the concrete should be finished level with the top of the mould,using a trowel and covered with a glass or metal plate to prevent evaporation.

Fig 1: Concrete Specimen

a) Curing of Specimen

- Casted specimen should be stored in a place at a temperature of 27° +/- 2°C for 24 +/- 0.5 hrs from the time addition of water to the dry ingredients.
- After that, the specimen should be marked and removed from the mould and immediately submerged in clean fresh water or saturated lime solution and kept there until taken out just prior to the test.
- The water or solution in witch the specimens are kept should be renewed every seven days and should be maintained at a temperature of 27° +/- 2°c.
- For design purpose, the specimen cured for 28 days.
- At last, for each reading, three specimen shall be casted and tested. Then, the average tensile strength will be taken.

Fig 2: Curing concrete specimen

b) Procedure of Splitting Tensile Test

- Initially, take the wet specimen from water after 7, 28 of curing; or any desired age at which tensile strength to be estimated.
- Then, wipe out water from the surface of specimen
- After that, draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.
- Next, record the weight and dimension of the specimen.
- Set the compression testing machine for the required range.
- Place plywood strip on the lower plate and place the specimen.
- Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate.
- Place the other plywood strip above the specimen.
- Bring down the upper plate so that it just touch the plywood strip.
- Apply the load continuously without shock at a rate within the range 0.7 to 1.4 MPa/min (1.2 to 2.4 MPa/min based on IS 5816 1999).
- Finally, note down the breaking load(P).

Fig 3: Testing Cylindrical Concrete Specimen

EXPERIMENTAL RESULTS:

Table 2 Slump Values Of Concrete Mixes For Various Percentages Of Coconut shell Replacement and addition of fibres.

Mix Id	Slump
CC	40
C1	40
C2	30
C3	28
C4	38
C5	27
C6	26
C7	36
C8	28
C9	25

Compressive Strength test

Table 3 Compressive Strength in N/mm2

Compressive Strength N/mm2				
Mix Id	Fibre %	Replacement of Coarse Aggregate with coconut shell	7 days Strength (Mpa)	28 days Strength (Mpa)
CC	0%	0%	13.2	18.03
C1		10%	17.5	22
C2		20%	13.7	21.36
C3	0.50%	30%	13.4	20.09
C4		10%	18.3	23.89
C5		20%	14.1	21.76
C6	1%	30%	13.9	20.87
C7		10%	18.2	23.03
C8		20%	13.98	21.54
C9	1.50%	30%	13.76	21.32

Table 4 Flexural Strength Test in N/mm2

Flexural Strength in N/mm2				
Mix Id	Fibre %	Replacement of Coarse Aggregate with coconut shell	7 days Strength (Mpa)	28 days Strength (Mpa)
CC	0%	0%	1.94	2.25
C1		10%	2.02	3.11
C2		20%	2.75	3.32
C3	0.50%	30%	2.65	3.29
C4		10%	2.12	3.25
C5		20%	2.89	3.51
C6	1%	30%	2.63	3.25
C7		10%	2.46	3.75
C8		20%	2.57	3.81
C9	1.50%	30%	2.51	3.79

CONCLUSION:

Slump Value Results

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test is used to ensure uniformity for different loads of concrete under field conditions. The slump values as per standard reference condition always lies between 25-50mm.and shape of aggregate should be angular. The slump values were found favourable for conventional concrete and similar values were visible for the C1 and C4.

Compressive Strength

Compressive strength is the ability to carry loads of material or structure on its surface without any cracking or deformation. An object under compression will reduce in size and, under tension, the size will continue to lengthen. The Compressive strength test helps to identify the overall strength and the above factors. By conducting this test, one can easily determine the strength psi of the concrete and the quality of the concrete being produced. The compressive strength was found maximum for sample C4 with 23.89 kN/m2 and similar results were found for the C7 and further concrete mix with addition of coconut shell reduces the strength of the concrete cube.

Flexural Strength

Flexural strength of Concrete, also known as Modulus of rupture, is an indirect measure of the tensile strength of unreinforced concrete. Modulus of rupture can also be defined as the measure of the extreme fibre stresses when a member is subjected to bending. Apart from external loading, tensile stresses can also be caused by warping, corrosion of steel, drying shrinkage and temperature gradient. The Flexural strength test was evaluated for 7 days and 28 days. The strength of the concrete was found to increase from C1 to C8 but further addition of concrete shell reduced the strength of the cubes.

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