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Partial replacement of Fine Aggregate with Foundry Sand and Cement with Coconut Shell Ash in Concrete

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Abstract :

Infrastructure development for a country is a principle development and concrete plays a vital role. Concrete is the world's largest consuming material in the field of construction. From time immemorial research over concrete has been going on to enhance its performance and strength. Nowadays, most concrete mixture contains supplementary cementitious material (SCM) which forms part of the cementitious component. The fast growth in industrialisation has resulted in tons and tons of byproduct or waste materials, which can be used as SCMs such as fly Ash, silica fume, ground granulated blast furnace slag, steel slag etc. The use of these byproducts not only helps to utilize these waste materials but also enhances the properties of concrete in fresh and hydrated states. In recent years, there has been great concern about introducing new supplementary cementitious materials (SCM) in place of ordinary Portland cement (OPC) in concrete. The aim of this study is to check the behavior of coconut shell Ash (CSA) and foundry sand with various proportions in concrete. Coconut shell is available in abundant quantity in local agricultural fields and considered as waste product. It is found that by incorporating the 10% of CSA into concrete results in the improvement of mechanical properties of concrete such as compressive, split tensile strength and flexural strength of concrete after every curing day respectively. Moreover, the modulus of elasticity enhanced while using 10% of CSA in concrete and the workability of fresh concrete was declined as the percentage of CSA increases. In addition to that, the use of CSA in concrete can reduce the total carbon foot print while reducing the overall cost of concrete manufacturing. In the present study, an attempt has been made to investigate the strength parameters of concrete made with partial replacement of cement by Coconut Shell Ash and fine aggregate by foundry sand. Here in the experiment an attempt has been made to increase the strength of concrete by replacing cement with 0%,5%,10%,15% and 20% of Coconut Shell Ash and fine aggregate with 0%,10%,20%,30% and 40% of foundry sand in a design mix of M50. Properties ofhardened concrete viz Ultimate Compressive strength, Flexural strength, Splitting Tensilestrength has been determined for different mix combinations of materials and thesevalues are compared with the corresponding values of conventional concrete.

INTRODUCTION:

Background The history of concrete dates back to the rein of the Greeks and Romans, since then till today in the field of concrete technology developments strive towards the achievement of higher and higher strength concrete. Structural concrete is used extensively in various kinds of civil

engineering structures. It is the most commonly used construction material consumed at a rate of approximately one ton for every living human being. Concrete is a composite material which essentially consists of cement, coarse aggregate (CA), fine aggregate (FA and water. Coarse aggregate gives the volume to the concrete and fine aggregate makes the concrete denser by filling the voids of coarse aggregate. Water hydrates and sets the cement which thus acts as a binder for all the ingredient particles of concrete. Concreteis the most important engineering material and the addition of some other materials may change the properties of concrete. With increase in trend towards the wider use of concrete for pre stressed concrete and high rise buildings there is a growing demand of concrete with higher compressive strength. The ultimate properties of concrete in terms of its strength, durability and economy depend not only on the various properties of its ingredients but also on the mix design standards, method of preparation, handling and curing conditions. Characteristic strength of concrete depends on its quality control and the extent of quality control is often an economical compromise and depends on the size and type of job. Economization is nowadays done by replacing cement with cheap, waste and recycled products. Mineral additions which are also known as mineral admixtures have been used with cements for many years. There are two types of materials crystalline and non- crystalline. Concrete is the widely used number one structural material in the world today, high cost of cement, used as binder, in the production of mortar, sandcrete blocks, lancrete bricks and concrete has led to a search for alternative. The overall relevance of concrete in virtually all civil engineering practice and building construction works cannot be overemphasized. The growing concern of resource depletion and global pollution has challenged many researchers and engineers to seek and develop new materials relying on renewable resources. These include the use of by-products and waste materials in building construction. Many of these by-products are used as aggregate for the production of lightweight concrete (Vishwas and Sanjay, 2013). 2 With the global economic recession coupled with the market inflationary trends, the constituent materials used for these structures had led to a very high cost of construction. On the other hand, building construction works and civil engineering practice in Nigeria depend, to a very large extent, on concrete as major construction material. The versatility, strength and durability of cement are of utmost priority over other construction materials. The basic materials for concrete are: cement, fine aggregate (sand), coarse aggregate (granite chippings or gravel) and water, the overall cost of concrete production depends largely on the availability of these constituents. Reduction in construction costs and the ability to produce light-weight concrete structures (LWC) are added advantages. The primary aim is to determining the suitability of partial replacement of cement with coconut shell ash (CSA) and palm kernel shell ash (PKSA) in concrete. The use of Coconut shell powder as a pozzolana in concrete was originated in Scandinavia during the early 1950's and was introduced to the United States in 1984. Coconut Shell Ash is an ultrafine airborne material with

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spherical particles less than 1 μm in diameter, the average being about 0.1 μm. It is approximately a hundred times finer than Portland cement. When it is used in concrete,it acts as a filler and as a cementitious material. The small Coconut Shell Ash particles fill spaces between cement particles and between the cement paste matrix and aggregate particles. The Coconut Shell Ash also combines with calcium hydroxide to form additional calcium hydrate through the pozzolanic reaction. Both of these actions result in a denser, stronger and less permeable material. Verma found that Coconut Shell Ash increases the strength ofzconcrete more 25%. Coconut Shell Ash is much cheaper than cement thereforeit is very important form economical point of view. Coconut Shell Ash also decrease the voidsin concrete. Pandit concluded that addition of Coconut Shell Ash to concrete increases the strength more than 17% due to their pozzolanic properties and reduces the permeability of concrete. Ghutke found that Coconut Shell Ash has been recognized as a pozzolanic admixture that is effective in enhancing the mechanical properties to a great extent.

OBJECTIVES

The main objective of this project is to know the behavior of concrete with partial replacement of cement with Coconut Shell Ash and fine aggregate with foundry sand at different proportions of replacement in M50 concrete and to study the effect ofzdifferent replacement levels of coconut shell ash on the strength development ofzmasonry mortar, concrete and to obtain the optimum replacement level of coconut shell ash based on strength requirements.

The objectives of study includes:-

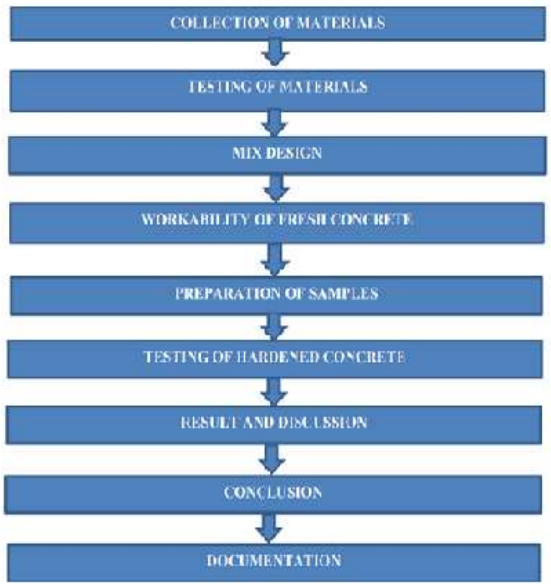
- Study of effects of coconut shell ash on cement mortar properties
- Design of the standard grade of concrete M50
- Mix design by partial replacement of cement by 5%, 10%, 15%, 20% coconut shell ash and 10%,20%,30%,40% foundry sand
- Casting of standard size cubes, beam and cylinder
- Testing of various specimens for compresive strength flexural strength and split tensile strength
- Test for durability aspects

METHODOLOGY:

General:

To improve the strength properties of concrete by partial replacement of cement with Coconut Shell Ash. Additionally Foundry Sand is also added so as to increase the strength properties of concrete. Foundry Sand contains Silica, it is used to increase the compressive strength of concrete. Coconut Shell consists amorphous silica and it lead to increase the compressive and flexural strength.

Flow Chart:



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Procedure:

Stage 1: Experimental work were conducted on mortar mixes by using different binder mix modified with different percentages of silica fume.This experimental investigation was carried out for three different combinations of cement and silica fumes. In each combination three different proportion of Coconut Shell Ash had been added along with the controlled mix without silica fume.

Stage2: Experimental works were conducted on concrete mixes by using different binder mix modified with different percentages ofzsilica fume.

EXPERIMENTAL INVESTIGATION ON MORTAR:

In this stage the study is done on the effects ofzCoconut Shell Ash on compressive strength of mortar at the age of 7 and 28 days when a part of cement is replaced by silica fume. Here we prepared mortar with ratio 1:3 from different types of cement + Coconut Shell Ash replacement as binder mix and sand as fine aggregate. Then its physical properties like consistency, compressive strength can be predicted. For each mix the compressive strength of (7.06 X 7.06 X 7.06) cube is to be recorded for different percentages of silica fume(cement/sand replaced) for particular mix, average compressive strength of three similar cubes has to be noted. Tests to study effects of Coconut shell powderon cement paste and mortar:- a.) Normal consistency of cement b.) Compressive strength of cement mortar a.) Normal Consistency of mortar:- This test was performed according to (B.S 12 : 1971). The test was used to estimate the w/c ratio for cement mortar which make vicat needle of normal consistency capable to penetrate a distance of about (5-7) mm from the base of the mold. Test Requirement: Cement: Ordinary Portland Cement (Grade 43) Coconut Shell Ash: Commercially available micro SiO2 or Coconut shell powder is used. 26 Apparatus Used: a.) Vicat's Apparatus with plunger of dia 10mm and length 50mm b.) Mould: In shape of frustum of cone c.) Metal Plate

FIG:-1

Test procedure to find Normal Consistency for Mortar:- Normal consistency of different binder mixes was determined using the following procedure referring to IS 4031: part 4 (1988): 1) 300 gm of sample coarser than 150 micron sieve is taken. 2) Approximate percentage of water was added to the sample and was mixed thoroughly for 2- 3 minutes. 3) Paste was placed in the vicat‟s mould and was kept under the needle of vicat‟s apparatus. 4) Needle was released quickly after making it touch the surface ofzthe sample. 5)Check was made whether the reading was coming in between 5-7 mm or not and same process was repeated ifznot 6) The percentage of water with which the above condition is satisfied is called normal consistency

RESULTS:

Test results Results of compressive strength of cement mortar and hardened concrete with partial replacement of Coconut Shell Ash and Foundry Sand are

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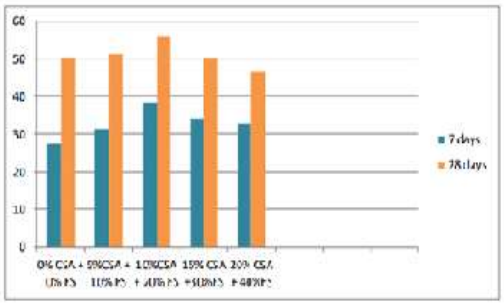
discussed in comparison with those of normal cement mortar and normal concrete respectively. Compressive strength of cement mortar:- The effect of Coconut shell powder and Foundry Sand on compressive strength of cement for 7 days and 28 days is determined in test. In order to study the effect of Coconut Shell Ash and Foundry Sand on compressive strength of cement mortar, the Coconut Shell Ash and Foundry Sand is to be added in different percentages (i.e. 5%, 10%, 15%,20% & 10%, 20%, 30%, 40% by weight) replacing the equivalent quantity of cement and sand separately. For each mix the compressive strength of cube is to be recorded for different percentages of Coconut Shell Ash and Foundry Sand(cement & sand replaced) for particular mix, average compressive strength of three similar cubes has to be noted. Compressive Strength of concrete:- The results of compressive strength were presented in Table. The test was carried out conforming to IS 516-1959 to obtain compressive strength of concrete at the age of 7 and 28 days. The cubes were tested using Compression Testing Machine (CTM) of capacity. The compressive strength is up to 38.42 N/mm2 and 55.80 N/mm2 at 7 and 28 days. The maximum compressive strength is observed at 10% replacement of Coconut Shell Ash and 20% replacement of Foundry Sand. There is a significant improvement in the compressive strength of concrete because of the high pozzolanic nature of the Coconut Shell Ash and Foundry Sand Increases its strength and durability factor.

FIG:-2

MIX	% of Coconut Shell Ash added	% of Foundry Sand Added	Compressive Strength(N/mm²)	
			7 days	28 days
M1	0	0	27.22	50.22
M2	5	10	31.36	51.35
M3	10	20	38.42	55.80
M4	15	30	34.23	49.82
M5	20	40	32.86	46.36



Graph:-1

Fig:-3

MIX	% of Coconut Shell Ash added	% of Foundry Sand Added	Split Tensile Strength(N/mm²)	
			7 days	28 days
M1	0	0	4.21	4.9
M2	5	10	4.26	5.96
M3	10	20	4.41	6.97
M4	15	30	4.38	6.23
M5	20	40	4.25	5.84

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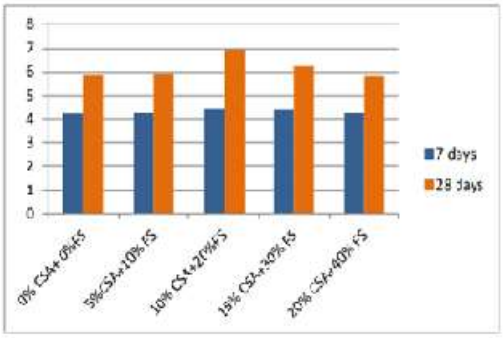

Graph:-2

CONCLUSION:

The main objective of this project was to know the behavior of concrete with partial replacement of cement from Coconut Shell Ash and foundry sand from sand at different proportions of replacement in M50 concrete and to study the effect of different replacement levels of Coconut Shell Ash and Foundry sand on the strength development ofzmasonry mortar, concrete and to obtain the optimum replacement level of Coconut Shell Ash and foundry sand based on strength requirements • After performing mix design for M50 as per IS 10262 and replacing the total cement content by different percentages as mentioned earlier for both ofthe mix design the beneficial effect of Coconut Shell Ash and foundry sand is observed. Concrete acquired a better packing of its constituents due to extremely small particles of Coconut Shell Ash and becomes more impermeable with strong transition zone between aggregate and cement paste. • In all observation addition ofzCoconut Shell Ash and foundry sand gives more compressive strength. It is observed from the test results that corresponding to 10% replacement of cement by Coconut Shell Ash and 20% of fine aggregate by foundry sand gives the best results. • Minimum 3 cubes were cast for each proportion and the average values of compressive strength have been presented. • The flexure strength at the age of 28 days of Coconut Shell Ash and Foundry sand concrete continuously increased with respect to conventional concrete and reached a maximum value of 15% replacement level for M50 grades of concrete. • The replacement of Coconut Shell Ash and Foundry sand is found to have increased the durability against acid attack. This is due to the silica present in Coconut Shell Ash which combines with calcium hydroxide and reduces the amount susceptible to acid attack.

FUTURE SCOPE:

• Although a lot of work has been carried out involving the use of Coconut Shell Ash and Foundry sand in concrete. In future, the size effects of Coconut Shell Ash and Foundry sand can be studied in detail. A detailed study of the microstructure at specific intervals throughout a year can give a very good idea about the reactions taking place in the concrete • Further study can be extended on various properties of concrete by changing the particles size of micro SiO2 and various grade of concrete.

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