An Investigative Study on Mechanical Properties of Concrete by Partial Replacement of Coarse Aggregate by Using Cockle Shells and Steel Slag

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Abstract*— Concrete is the most versatile construction material because it can be designed to withstand the harshest environments while taking on the most inspirational forms. Engineers are continually pushing the limits to improve its performance with the help of innovative chemical admixtures and supplementary cementitious materials. Nowadays, most concrete mixture contains waste materials present in this environment as a replacement. These can get extinct when they are used continuously for a long time. Cockle shells are present on the sea shores. These shells are used in lime factories as these shells contain 97% of CaCO3. Some cockle shell left untreated and is left on the seashores. These cause bad smell to the environment and also a negative impression on the surroundings. The cockle shells are made into chips of size 10mm to 20mm and added to the concrete as the partial replacement of coarse aggregate. The shell replacement in the concrete mixes varies 0%, 10%, 20%, 30%and 40% by weight of coarse aggregate.

Index Terms*— Green building materials, Recycling, Waste reduction, Eco-friendly construction

I. INTRODUCTION

The concrete is made by mixing cement, sand, coarse aggregate and portable water. In concrete 60-75% by volume of aggregate, 25-40% of cement, water and 1-2% of voids are used. The strength of concrete depends upon the properties of ingredients. By adjusting the proportions of the ingredients, concrete of different strength can be prepared. In fresh and hardened states of concrete to modify certain specific properties admixtures.

Aggregates are obtained from two primary sources, viz quarries and river beds. Environmental issues occur when there is extraction of sand and gravel. The aggregate extraction and processing are the principal causes of environmental problems. The need for replacement of natural aggregates is a growing requirement to meet the demand for aggregates in concrete. Recent studies aim on the locally available waste to be used as aggregates instead of natural aggregate materials. Such a waste is the seashells obtained from coastal areas, freshwater lakes and riverine areas.

. Recent studies aim on the locally available waste to be used as aggregates instead of natural aggregate materials. Such a waste is the seashells obtained from coastal areas, freshwater lakes and riverine areas. Recent investigation of sea shells has indicated greater scope for their utilization as a replacement to cement and aggregate in concrete. As they grow old, the shells increase in size which becomes strong compact casing for the mollusc inside. The hard shells are regarded as waste material, which are accumulated in many parts of the country, when dumped and left untreated cause unpleasant smell Cockle shell as one of the mixing ingredient in concrete production thus opening innovation in concrete research and at the same time offering. Therefore cockle shells are a viable option as partial replacement to coarse aggregate because they contain a large amount of calcium carbonate. Also the calcium carbonate can help improve resistance against heat and chemicals. Cockle shell obtained from dumbing site are washed and cleaned. before use.

1.2 Scope and objective:-

1. The possibility of integrating this the waste such as cockle shells and steel slag in concrete production is main objective of this project.
2. Effort towards preserving natural coarse aggregate.
3. To examine the suitability of cockle seashell as partial replacement of coarse aggregate in concrete.

4. To investigate the effect of concrete containing. various percentage of cockleshells and steel slag Partial coarse aggregate replacement towards compressive and tensile strength.
5. To evaluate the possibility of reducing quantity of natural coarse aggregate in concrete.

II. LITERATURE REVIEW

Swaptik Chowdhury, Mihir Mishra, Om Suganya The incorporation of wood waste ash as partial cement replacement material for making structural grade concrete. With increasing industrialization, the industrial byproducts (wastes) are being accumulated to a large extent, leading to environmental and economic concerns related to their disposal (land filling). Wood ash is the residue produced from the incineration of wood and its products (chips, saw dust, bark) for power generation or other uses. This paper presents an overview of the work and studies done on the incorporation of wood ash as partial replacement of cement in concrete from the year 1991 to 2012.

Bashar Taha (2009) in their work "Utilization waste recycled glass. sand/cement (RSG) and pozzolanic glass powder (PGP) was examined in their study. There is no major difference found in compressive strength while replacing RSG while compressive strength reduced by 16% whereas 10.6% decrement noted at 28 and 364 days when 20% of Portland cement was. replaced by PGP. British Standard BS 812 Part 123:1999 was followed while monitoring the potential expansion of concrete due to alkali-silica reaction (ASR). Their work failed to show good results with that of sand/cement both.

III MATERIALS AND METHODOLOGY

3.1 ORDINARY PORTLAND CEMENT :-

Portland cement is the most common type of cement in general use around the world, used as a basic ingredient of concrete, mortar, stucco, and most non-specialty grout. It developed from other types of hydraulic lime in England in the mid19th century and usually originates from limestone. It is a fine powder produced by heating materials in a kiln to form what is called clinker, grinding the clinker, and adding small amounts of other materials. Several types of Portland cement are available with the most common being called ordinary Portland cement (OPC) which is grey in color, but a white Portland cement is also available.

Fig 3.1 CEMENT

3.1.2 AGGREGATES

3.1.2.1 FINE AGGREGATES

Fine aggregate, which may be granular material or crushed stone, is a fundamental component of concrete. The quality of the fine aggregate and the density of the fine aggregate both have a significant impact on the hardened qualities of the concrete. The river sand used for our investigation is collected form locally available which is conforming to Zone III as per Indian Specification 383-1970 codel provisions. Specific gravity and fineness modulus of the sand are 2.61and 2.63 respectively. The sand should be air dried before while use to avoid buckling.

3.1.2.2 COARSE AGGREGATE:-

Aggregation of solid particles other than paste is called aggregate. They are inert and inexpensive. Aggregate has a definite influence on the strength of hardened concrete. In this project 20 mm and 10 mm aggregates used. Aggregate occupy about 75 to 80% of the total volume of concrete and they greatly influence the properties of concrete. This reduces the shrinkage effect of cement and makes the concrete durable. Generally aggregates are classified into two types as fine and coarse aggregate. The aggregates which passes sieve size of 4.75 mm to 75 microns are known as fine aggregates and retained on 4.75mm are known as coarse aggregates as per Indian stranded code 383-1970. Flaky and elongated aggregate particles are not used in any type of constructions. Aggregate having length greater than width are termed flaky and those with both Length and width greater than thickness are termed elongated. Those coarse aggregates are crucial components in concrete mixes, providing strength,

durability, and volume stability. The shape and size of aggregates can influence the workability of the mix.

Fig 3.3 COARSE AGGREGATES

3.1.3 COCKLE SHELLS

Waste cockle shells that used in this experiment were taken from a stall in Perak. The shells were washed with raw water to remove dirt and been dried using oven at 110°C for 2 hours. It were crushed using woodden hammer into pieces of 10mm to 20mm. These cockle shell pieces was sieved in the shaker sieve for 10 minutes to segregate according to the ranges of particle sizes Cockles is a type of bivalve shellfish that grows well in muddy coastal area. The shells that been dumped and left untreated may cause unpleasant smell and disturbing view to the surrounding. Seashell contained of 95-99% by weight of CaCO3 which has enable it to be applied for quite a number of purposes thermal decomposition process known as calcination, CaCO3 can be Converted into CaO .

$$Caco_3 \longrightarrow Cao + Co_2$$

Fig 3.4 COCKLE SHELLS

3.1.4 STEEL SLAG:-

Steel Slag is the main component of this study, which is locally available material. Steel Slag used in is work is collected from Jai Jawala Steel industry Baddi. Steel slag is a byproduct obtained either from conversion of iron to steel in a Basic Oxygen Furnace (BOF), or by the melting of scrap to make steel in the Electric Arc Furnace (EAF). The molten liquid is a complex solution of silicates and oxides that solidifies on cooling and forms steel slag Steel slag is defined by the American Society for Testing and Materials (ASTM) non-metallic product. consisting essentially of calcium silicate sand ferrites combined with fused oxides of iron, aluminum, manganese, calcium and magnesium that are developed simultaneously with steel in basic oxygen, electric arc, open hearth furnaces. (Kalyoncu, 2001). Steel furnace slag is produced in a Basic Oxygen Furnace (BOF) Electric Are Furnace (EAF) at a byproduct of the production of steel. In the Basic Oxygen Furnace (BOF), the hot liquid metal from the blast furnace, scrap and fluxes, which contain lime (CaO) and dolomitic lime, are charged. to a furnace (Shi, 2004).

Fig 3.5 STEEL SLAG

3.2 METHODOLOGY:-

The experimental Investigation was carried out in different stage.

Stage 1:- The waste Materials cockleshells and steel slag were collected and cleaned and crushed into required size.

Stage 2:- Physical properties of Materials used is determined.

Stage 3:- Sample were casted for determination of strength for the conventional concrete.

Stage 4:- Experimental works conducted on cockle shell and steel slag. concrete Mixes by using different Percentage.

Stage 5:- Conducting experimental testing the moulds in strength characterstics.

Stage 6:- Comparing the results obtained.

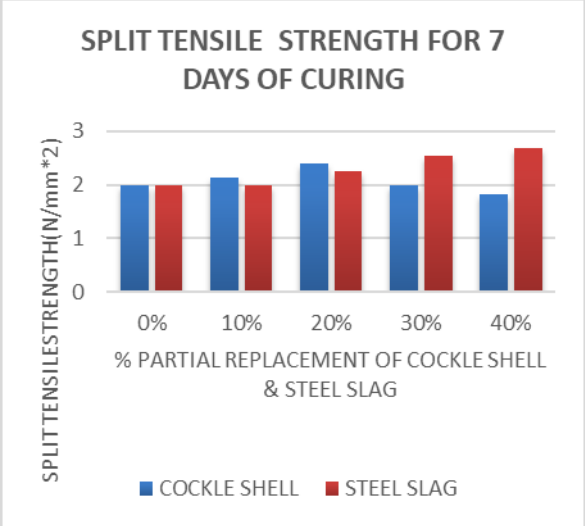
Fig 4.8 Testing of split tensile strength

TABLE 4

COCKLE SHELL REPLACEMENT		STEEL SLAG REPLACEMENT	
PERCENTAGE OF REPLACEMENT (%)	SPLIT TENSILE STRENGTH (N/mm^2)	PERCENTAGE OF REPLACEMENT (%)	SPLIT TENSILE STRENGTH (N/mm^2)
0%	1.98	0%	1.98
10%	2.19	10%	1.98
20%	2.40	20%	2.4
30%	1.9	30%	2.54
40%	1.83	40%	2.68

SPLIT TENSILE STRENGTH:-

Split tensile strength results for 7 days for replacement of different cockle shell and steel slag content



WORKING IMAGES

7 CONCLUSIONS

1. Based on the present experimental investigation the partial replacement of coarse aggregate by cockleshells and steel slag gives high strength at certain point than conventional concrete.
2. In case of cockle shell replacement the Maximum compressive strength observed at 20% at the age 28 days is 39.11 N/mm*2 is 1.22 times more than conventional concrete.
3. In case of split tensile strength Maximum strength observed at 20% of cockle shell replacement is 2.61 which is 1.08 times More than conventional concrete.
4. After 20% of increasing the Cockle shell replacement the strength of concrete gradually decreases.
5. The Maximum compressive strength in case of steel slag replacement we observed incremental change at 40% of replacement is 40.88 N/mm*2 which is 1.277 times more than conventional concrete.
6. In case of split tensile strength maximum strength observed at 40% of steel slag replacement is 3.32 N/mm² which is 1.33 I times more than conventional Concrete.

7. From the above considerations the partial replacement of coarse aggregate by cockle shells and steel slag incremental change in strength properties of the Concrete

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