Behavior of Reinforced Concrete Beams with Coconut Shell as Coarse Aggregates

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Abstract: **The high cost of conventional building materials is a major factor affecting housing delivery in world. This has necessitated research into alternative materials of construction. The project paper aims at analyzing flexural and compressive strength characteristics of concrete produced using crushed, granular coconut as substitutes for conventional coarse aggregate with partial replacement using M30 grade concrete. Beams are casted, tested and their physical and mechanical properties are determined. The main objective is to encourage the use of these 'seemingly' waste products as construction materials in low-cost housing. It is also expected to serve the purpose of encouraging housing developers in investing these materials in house construction.**

Keywards: Experimental Investigation, Test Setup, Load-deflection curve, Stress-strain curve, Load Carrying Capacity

I. INTRODUCTION

The high demand for concrete in the construction using normal weight aggregates such as gravel and granite drastically reduces the natural stone deposits and this has damaged the environment thereby causing ecological imbalance (Short and Kinniburgh, 1978).Therefore, there is a need to explore and to find out suitable replacement material to substitute the natural stone.In developed countries, the construction industries have identified many artificial and natural lightweight aggregates (LWA) that have replaced conventional aggregates thereby reducing the size of structural members. This has brought immense change in the development of high rise structures using LWC. However, in Asia the construction industry is yet to utilize the advantage of LWC in the construction of high rise structures. Coconut Shell (CS) are not commonly used in the construction industry but are often dumped as agricultural wastes. It was concluded that the CSs were more suitable as low strength-giving lightweight aggregate when used to replace common coarse aggregate in concrete production. **Gunasekaran** studied the properties of concrete using coconut shell as coarse aggregate were investigated in an experimental study. Compressive, flexural, splitting tensile strengths, impact resistance and bond strength were measured and compared with the theoretical values as recommended by the standards. The bond properties were determined through pull-out test. Coconut shell concrete can be classified under structural lightweight concrete. **O.T. Olateju** in this paper reports the exploratory study on the suitability of the periwinkle shells as partial or in concrete works. Physical and mechanical properties of periwinkle shell and crushed granite were determined and compared. A total of 300 concrete cubes of size 150 × 150 ×150 mm3 with different percentages by weight of crushed granite to periwinkle shells as coarse aggregate in the order 100:0, 75:25, 50:50, 25:75 and 0:100 were cast, tested and their physical and mechanical properties determined.**Majid Ali** in this paper presents the versatility of coconut fibres and its applications in different branches of engineering, particularly in civil engineering as a construction material.Not only the physical, chemical and mechanical properties of coconut fibres are shown; but also properties of composites (cement pastes, mortar and/or concrete etc), in which coconut fibres are used as reinforcement, are discussed. Coconut fibres reinforced composites have been used as cheap and durable non structural elements. The aim of this review is to spread awareness of coconut fibres as a construction material in civil engineering.

II. EXPERIMENTAL INVESTIGATIONS

A. Test specimen details

All the ingredients of the mix were weighed and mixed in the concrete mixture machine as per the concrete mix design. The steel mould was used for casting the beam specimens. Before mixing the concrete, the moulds were kept ready by placing it on a horizontal surface. The sides and bottom of all the moulds were properly greased for easy demolding. The concrete was placed in the mould in three layers and compaction was done using needle vibrator. Proper care was taken for uniform compaction and surface finish throughout the beam.

BEAM DENTITY	PROPERTY
CC	PPC
CS 25%	PPC
CS 50%	PPC
CS 75%	PPC

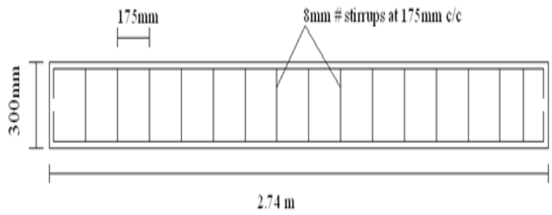

Fig. 1 Reinforcement details of beam elevation

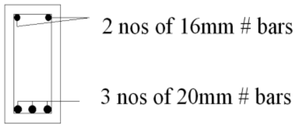

Fig. 2 Reinforcement details of beam section

B. *Test setup*

The experiments were conducted on a loading frame of capacity 400kN. The beams were tested as a simply supported beam with a clear span of 2500mm and it is subjected to two point loading. The loading set-up consists of a load cell, hydraulic jack and a hand pump to apply the load. The experimental set-up is shown below. Steel pellets for the Demec gauge strain measurement was pasted on the compression side and tension side

Fig. 1 Concrete beam casted using coconut shell as coarse aggregates

III. TEST RESULTS

A. *Failure mode*

In the control concrete beam initial crack is 35 kN. The coconut shell 25% beam initial crack is 25 kN. The coconut shell 50% beam initial crack is 30 kN. The coconut shell 75% beam initial crack is 35 kN. The failure beams as shown in the Fig.ure.

Fig. 2 Showing shear cracks

Fig. 3 Deflected profile of beam under symmetric loading

IV. LOAD CARRYING CAPACITY

The strength beam without coconut shell is 90 kN with a central deflection of 680 mm.The strength beam with coconut shell 25% is 90 kN with a central deflection of 745 mm.The strength beam with coconut shell 50% is 90 kN with a central deflection of 1010 mm. The strength beam with coconut shell 75% is 70 kN with a central deflection of 1870 mm. The load deflection behavior of the test specimens are shown in Figure

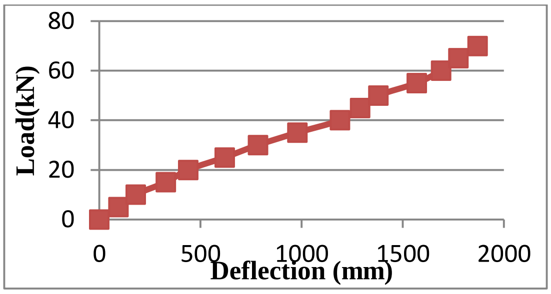

Fig. 4 CS (75%)

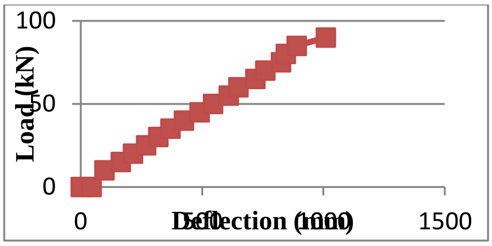

Fig. 5 CS(50%)

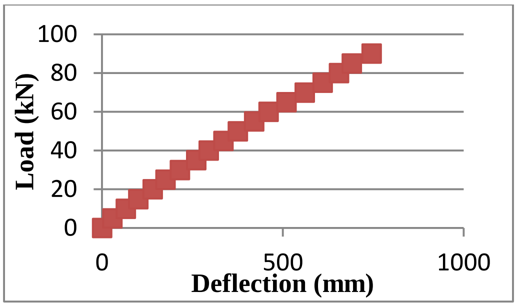

Fig. 6 CS(25%)

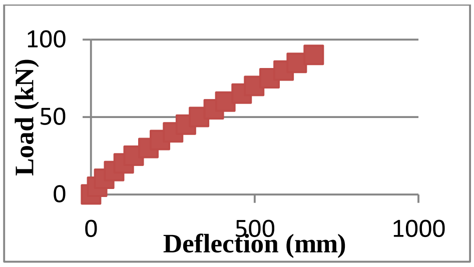

Fig. 7 CC

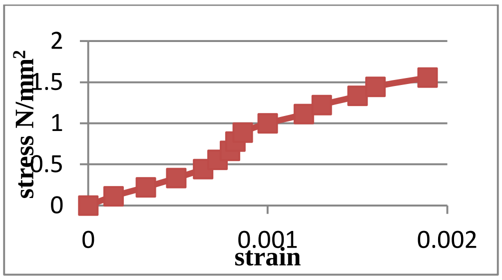

Fig. 8 CS (75%)

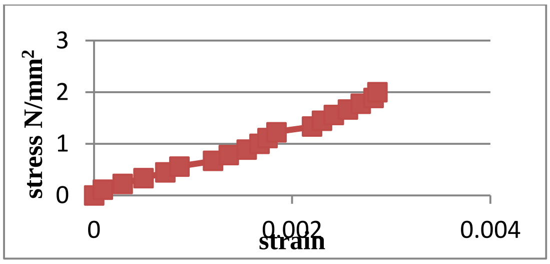

Fig. 9 CS(50%)

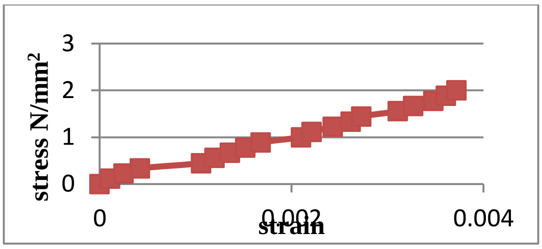

Fig. 10 CS(25%)

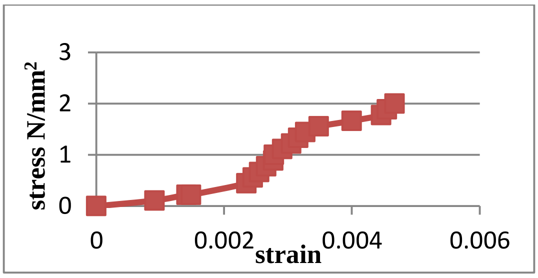

Fig. 11 CC

V. CONCLUSION

The experimental results of four beams, two each in CS and the NWC are presented in this paper. The comparison of mechanical properties and structural behaviour of the NWC and CS beams is discussed. The crack width, deflection, ultimate strength, concrete and steel strains are analyzed and compared for both beams. Based on the results, the following conclusions may be drawn. The overall flexural behaviour of reinforced PKSC beams used in this study closely resembles that of equivalent beam made with NWC.

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