ABSTRACT

Conventional reinforced concrete uses steel rebars. However, steel reinforcement is still expensive for many people who want to build earthquake resistant houses. To overcome the difficulty, an economical but safe constructional material is needed. Natural fibres can be one possible material, as they are cheap and locally available in many countries. In this work, rope made of coir fibre is used as replacement to steel rebars in Coir Fibre Reinforced Concrete (CFRC) slabs. Natural fibres are prospective reinforcing materials and their use until now has been more traditional than technical. They have long served many useful purposes but the application of materials technology for the utilization of natural fibres as the reinforcement in concrete has only taken place in comparatively recent years. The distinctive properties of natural fibre reinforced concretes are improved tensile and bending strength, greater ductility, and greater resistance to cracking and hence improved impact strength and toughness. A new material for roof panel in a composite of concrete and coconut fiber ropes as reinforcement instead of steel rebar is expected. These coir rope reinforced bio-composite concrete panels are obtained by reinforcing the coir ropes of small diameter in between concrete layers using epoxy resin.
To ascertain the properties of bio-composite panels under flexural loading condition, forty eight types of slabs of length 750mm, width 500mm and depth varied as 40mm and 60mm. The percentage of reinforcement used in the slabs are 0.95%, 1.43% and 1.91%, which are arrived at from the three percentage of coir fibre volume fraction (0.5%, 0.75% and 1.0%). Coir ropes of diameter 7.07mm were used in these experiments and coir ropes were used as main reinforcement in both directions. The coir ropes are tied with Nylon zip ties. To compare the properties of composite slab with other conventional reinforced slabs, 8 mm dia GFRP and Steel reinforcements are considered.

Initially to obtain the mechanical strength properties of M20 grade concrete used in this study, compressive strength, split tensile strength, modulus of rupture and modulus of elasticity tests were conducted. Mechanical properties of companion specimens were used in the analytical investigations. Flexural tests on 144 slab panels were conducted and load-deflection curves under middle third loading were drawn. Load carrying capacity of different slab specimens were compared and discussed with their mode of failure. The experimental results were validated by conducting a finite element analysis using ANSYS 10. Concrete was model using ‘SOLID 65’ element and the reinforcements including fibres were model using ‘LINK 8’ element. ANSYS model predicted the experimental behaviour of beams very closely.
A theoretical analysis is carried out to predict the behaviour of concrete sections. The behaviour of the sections at various stages of loading i.e. from the initial uncracked phase to the final (ultimate) condition at collapse is required to describe the serviceability and strength conditions. In this study, a rectangular slab section is considered with tension reinforcements only. The design of Coir/GFRP reinforced concrete members under flexure is analogous to the design of steel reinforced concrete members. The flexural capacity of concrete members reinforced with Coir/GFRP reinforcements can be calculated based on assumptions similar to those made for members reinforced with steel reinforcements. Both concrete crushing and Coir/GFRP rupture are acceptable failure modes in governing the design of Coir/GFRP reinforced concrete members provided that strength and serviceability criteria are satisfied.

Besides its ability to sustain loads, natural fibre reinforced concrete is also required to be durable. Hence a separate study has been carried out to assess the effect of different environment on properties of slab panels. This experimental program consists of determination of mass loss and strength deterioration against HCL and Na2SO4 attacks of slab specimens. From the studies, 5% reduction due to HCl acid attack and 2% reduction due to Na2SO4 for coir rope and 1% reduction due to HCl acid attack and 2% reduction due to H2SO4 for coir rope coated with epoxy resin were observed. The micro-structural properties of fresh natural fibres as received condition
and natural fibres reacted with concrete under accelerated curing conditions for two years were also ascertained. SEM and EDAC tests were conducted on reacted as well as as received natural fibres and results are discussed.

Finally, it is concluded that coir fibre ropes can be used as reinforcement in concrete slabs. Since load carrying capacity is much less than conventional reinforced concrete slabs, these composite slabs can be used for temporary modular construction purpose only. The advantage of using such rural fibres provides generally a lower cost in construction than using virgin fibres and the elimination of the need for waste disposal in landfills. Interestingly the utilization of these fibres in concrete leads to an effective solid waste management technique. Since it is a basic study only, more research on this topic is required to use these slabs in conventional construction.