DEVELOPMENT OF BIOCOMPOSITE CONCRETE PANELS FOR LOW-COST HOUSING

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Abstract. This study focused on the possibility of developing biocomposite concrete panels with coir fibers to be used as a low-cost construction alternative. Coir fibers were used to completely replace steel reinforcement and natural resin was the binding material. Two types of biocomposite panels with single and double layers of woven coir fiber were developed. The performance of the biocomposite for both wall and slab panels was evaluated under flexural and axial-compression loadings.

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Locally available coir fibers of 0.48 mm dia were collected from coir rope industries. The size of the panels was 750 × 500 × 60 mm, and thickness of a single biocomposite layer was 10 mm. The biocomposite concrete (BCC) panels were prepared by placing a layer of concrete into a mold of the same size. Concrete mix was designed to achieve a target mean compressive strength of 20 MPa. The natural fiber composites may undergo a reduction in strength and toughness as a result of weakening of fibers by the combination of alkali attack and mineralization through the migration of hydrogen products into lumens and spaces. Therefore, to enhance durability, coir fibers were immersed in silica-fume slurry for 12 h and oven-dried at 70°C for 2 h. The coir fibers were formed into 30-mm-square grids and placed over the concrete with a locally available natural resin from the neem tree (*Azadirachta indica*). The top surface was covered with concrete. Biocomposite layers were placed in the tension zone (10 mm from the bottom) of the slab specimens and in the center of the wall specimens. The specimens were demolded after 24 h and permitted to cure under water for 28 da. The slab specimens were tested for third-point flexural loading and wall specimens for axial compression. For comparison purposes, concrete slab and wall panels that were reinforced with 6-mm-dia steel mesh were also cast.

RESULTS AND DISCUSSION

Figure 1 shows the load-deflection curves (average values for three specimens) under flexure for the conventional steel-reinforced concrete (SRC) slab and the 10-mm-thick single-layered and 20-mm-thick double-layered BCC slabs. The fracture load obtained for the SRC slab was 7 kN at 0.05-mm deflection. An ultimate load of 41 kN was obtained at 5-mm deflection for single- and double-layer BCC slabs, and fracture occurred at 5.25 and 3.8 kN with ultimate loads of 17 and 21 kN, respectively. The deflection corresponding to the fracture for single- and double-layer BCC slabs was 0.47 and 0.48 mm with an ultimate load at 3 and 3.5 mm, respectively. Although the load-deflection values for

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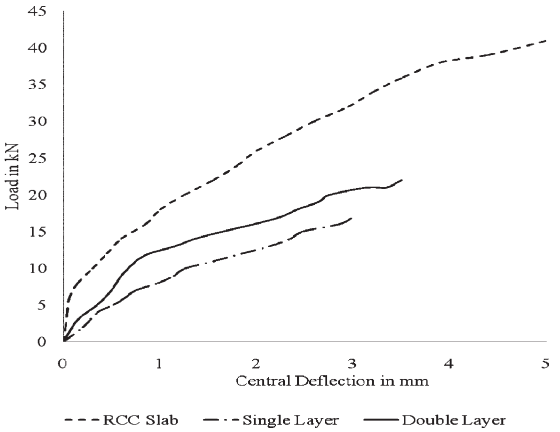

Figure 1. Load vs deflection for slab panels in flexure.

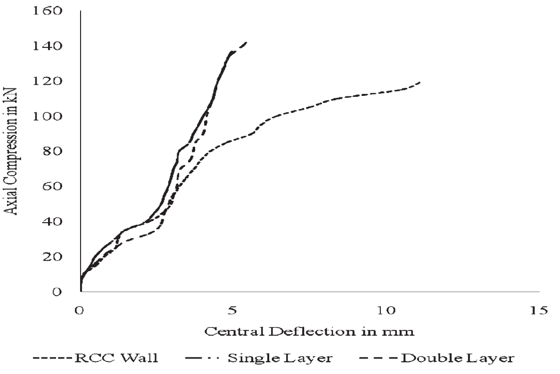

Figure 2. Load vs deflection for wall panels in compression.

the BCC slabs were lower than that of the SRC slabs (58 and 46% for single- and double-layered biocomposite wall panels), they possessed similar performance under flexural loading. This performance could potentially be improved in the composite preparation process and by using synthetic binders.

Figure 2 shows the load-deflection curves (average values of three specimens) under compression for the SRC wall panels and the single- and double-layered BCC wall panels. The BCC performed similarly to the SRC to an axial-compressive load of 40 kN and exceeded the performance of the SRC to an axial compressive load of 140 kN. The fracture deflection for all wall panels was about 2 mm. The ultimate load noted for the SRC wall panel was 119 kN at a deflection of 11.1 mm. However, the single- and double-layer BCC wall panel specimens had ultimate loads of 136 and 143 kN at deflections of 4.95 and 5.5 mm, respectively. From Fig 2, it is also evident that the stiffness of composite panels at postfracture is greater than that of SRC wall. Improved bonds between the biocomposite layer and concrete might provide higher resistance to compression and lead to the better performance.

CONCLUSIONS

It was concluded that the development of useful biocomposite layered concrete panels is feasible. They exhibit excellent performance under compression and reasonable performance in flexure. It is felt that there is a substantial opportunity to obtain good flexural panels by adopting proper methods for composite preparation and optimizing the concentration of filler, binder, and cement matrices.

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