Axial Response of Hemp-Fiber Composite Tube under Quasi-Static Compression and Impact Crushing

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ABSTRACT

Besides being eco-friendly, hemp fiber, a natural fiber, has a potential for use as fiber reinforcement for energy absorption structures. The advantage of the structure is to reduce the impact energy of a crash on the attached member or especially for occupants in an automotive body. In this study, the energy absorption capability and failure response of hemp fiber tubes were investigated by applying an axial static compression and impact crushing. Three fiber volume fractions of hemp fiber tubes and epoxy resin tubes were studied. It was found that epoxy tube and hemp fiber tube with low fiber volume fraction behaves with a brittle failure mechanism, but progressive failure was found in tubes with high fiber content. Brittle failures let the member absorb less crushing energy, but progressive failures let high fiber tubes have high energy absorption. Progressive failure was found in high fiber tubes due to the tensile loading resistance of hemp fiber, especially that fiber aligned in the circumferential direction. For high volume content of 37.0%, the sample has a high specific energy absorption of 65.76 J/g, which is 20 times that of epoxy without reinforcing fiber. Low content of hemp fiber tube can be used as an energy absorbing structure for quasi-static axial compression, but high content of hemp fiber tubes are better in an impact crushing situation. It is hoped that synthetic fiber will be substituted by hemp fiber in some automotive applications.

Keywords: Hemp, Hemp composite, Energy absorption structure, Impact, Natural fiber