The applications of sisal fibre-based materials in the built environment: opportunities for South Africa

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Introduction:

The building sector represented the largest uptake globally of natural fibre reinforced composites (NFRCs)1 in 2005 (Sharma et al, 2007). As the sector which consumes about 50% of all raw materials extracted from the Earth's crust annually (Koroneos and Dompros, 2007), the major reason for this trend is a growing realisation that a radical shift in feedstock – from non-renewable to renewable materials – is needed if the building sector is to continue to deliver much needed physical infrastructure for the benefit of current and future generations.

Replacing conventional building materials with NFRCs can yield a range of environmental and economic benefits. The environmental advantages, which are generalizable across NFRCs, include lower environmental impacts of reinforcing fibre production (Joshi et al, 2004), and sequestration of carbon dioxide from the atmosphere during the crop cultivation stage. Furthermore, in many instances, the initial cost and the maintenance of the NFRC have been shown to be lower (Umair, 2006). However, production of NFRCs is not environmentally neutral. As compared to conventional building materials, a major limitation shared by all NFRCs is the tendency to have a shorter service life (lower durability) – this aspect has been the subject of much research and development (R&D) since the 1980s (Berhane, 1987; Canovas, 1992; RD Toledo Filho et al, 2009; FA Silva et al, 2010)Furthermore, the agricultural input needs, which typically determine environmental performance, differ from one natural fibre to the next, thus a case by case examination of each natural fibre from a life cycle perspective is warranted. A range of natural fibres are currently the focus of R&D around the world with a view to use them in structural, semi-structural and non-structural building and construction applications. They include the bast fibres - flax, hemp, jute, kenaf and sisal, a leaf fibre. Table 1 provides a comparison of the performance properties of some natural and man-made fibres. This chapter explores the potential building and construction applications of sisal, a leaf fibre which is currently the subject of R&D at CSIR Built Environment. As compared to the popular bast fibres, sisal fibres are obtained from the Agave2 Sisalana plant which has lower input needs, is able to resist drought and thrives on marginal land which is unsuitable for growing other crops.

The sections that follow present brief overviews of NFRCs and the Agave Sisalana plant. This is followed by an in-depth review of the mechanical properties and the challenges of developing sisal fibre reinforced cementitious composites that are fit for long-life building applications. Thereafter, the potential environmental performance of sisal fibres is explored through a comparative life cycle assessment study. Finally, the opportunities for developing a strong sisal sector in South Africa; and the potential social and economic benefits of substituting conventional building materials with NFRCs are identified and discussed.