Experimental Investigation of Recycled Carpet Composites for Barrier Structures

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Project objectives and goals

In the UK, approximately 400 000 tonnes of carpet waste are sent to landfill annually (Bird, 2014). However, the landfill option is becoming increasingly impractical due to environmental impact considerations, reduced availability, and increasing cost (Sotayo et al. 2015). Furthermore, carpet textiles are non-biodegradable, and their disposal to landfill results in the release of methane (CH_4) and carbon dioxide (CO_2) to the atmosphere, and methane emissions are more harmful (by a factor of 20) than CO_2 emissions (United Nations Environment Programme, 2002).

Increasing recycling is a major goal of the current environmental agenda. The study described herein contributes towards this goal via the development of a waste carpet structural composite material, and the characterisation of its mechanics/physical properties. It is anticipated that such materials can replace other common materials (e.g. timber, PVC etc) in fencing or other barrier-type applications. Consequently, the study also includes an investigation of the load-deformation response of a post and rail barrier/fence structure fabricated from carpet-based composite material, and seeks to evaluate its stiffness characteristics relative to those of a similar timber fence (benchmark data).

Structural analysis and testing

Carpet-based composites have been fabricated into rectangular cross-section beams and tested in three-point bending and compared with similar tests on timber and PVC beams (benchmark materials). The flexural moduli obtained from these tests are listed in Table 1.

Table 1: Flexural moduli of carpet-based composite, timber and PVC materials

Material	Flexural modulus [GPa]
Recycled carpet-based composite	2.6
Timber	10
PVC	2.5

The elastic properties of timber were used to analyse a two-bay post and rail fence (a benchmark structure) using ANSYS FE software (see Fig 1). The results of the timber FE model were validated by means of static load-deformation tests carried out on a full-scale timber fence (see Fig 2). Using the elastic properties of the carpet waste composite material in the FE model, the load-deformation response of a similar composite fence was investigated. In addition, the research will undertake design optimisation of the carpet composite sections and the overall geometry of the structure to enable it to achieve a load-deformation response similar to that of the timber fence.

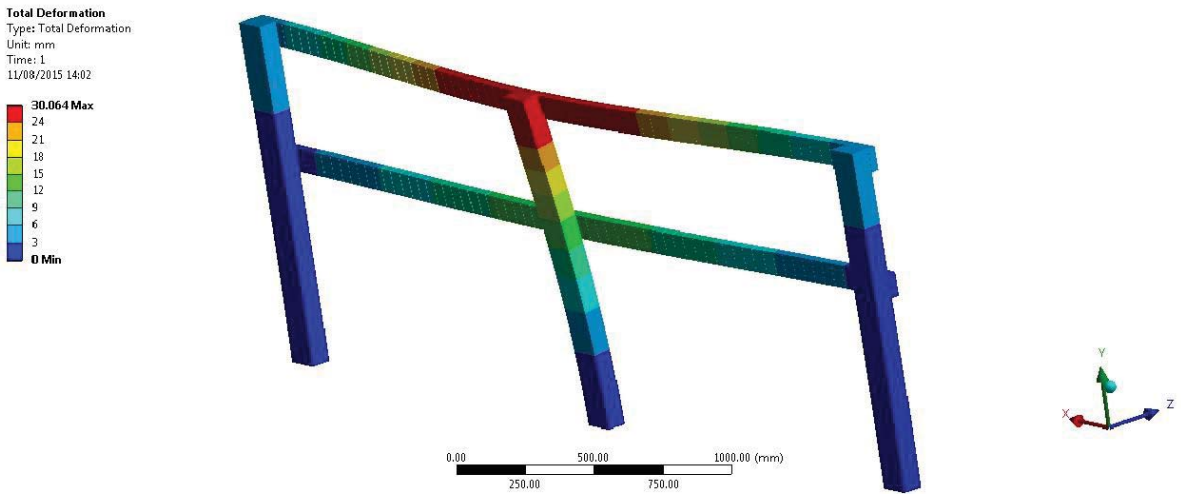

Fig 1 *Contour plot showing the deflections of the two-bay timber fence due to an out-of-plane load of 1400 N at the top of the middle post*

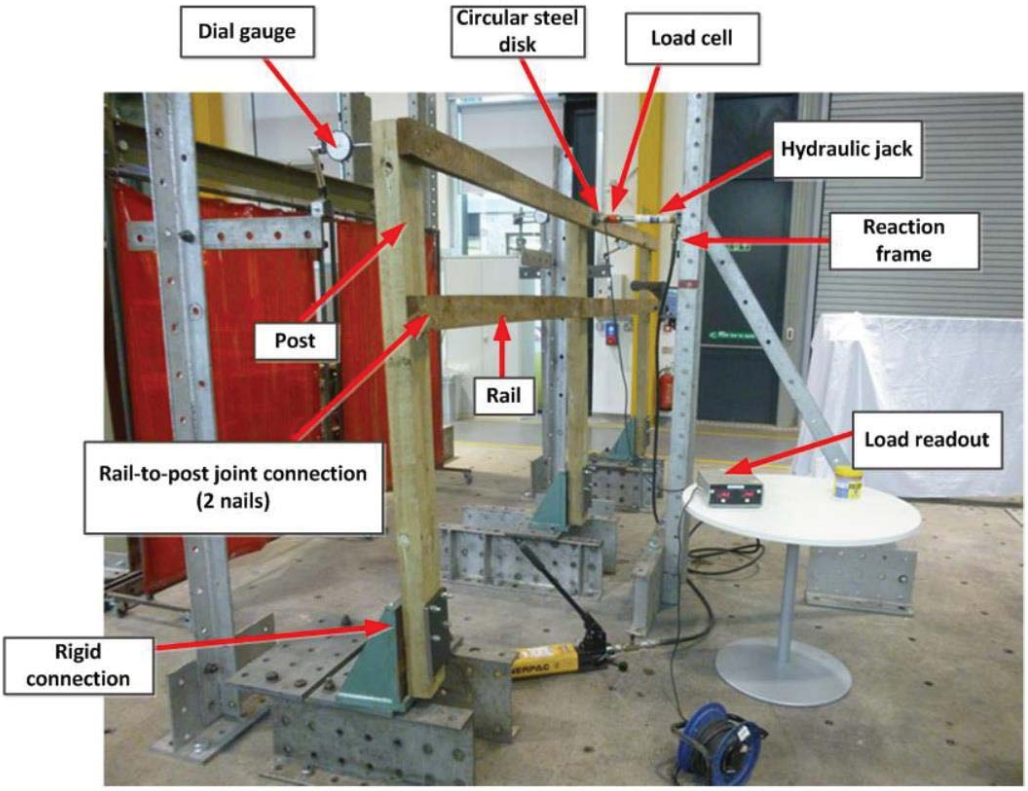

Fig 2 *Image showing the load-deformation test setup of the two-bay timber fence*

Potential for application of results

The results obtained so far from the analysis and testing demonstrate the potential of the carpet composite as a potential alternative to some common materials used in fencing applications, such as timber and PVC. Furthermore, the successful outcome of the research currently underway offers the prospect of a viable remediation pathway for carpet waste, bringing both economic and environmental benefits.

References

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