From dry yarns to complex 3D woven fabrics: a unified simulation methodology for deformation mechanics of textiles in tension, shear and draping

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Abstract

Common methods of modelling the behaviour of fibrous materials, such as yarns and (woven) fabrics, is to treat them as continuous solids. The fibrous behaviour is then taken into account by appropriate constitutive laws. However, the development of such constitutive laws is very complex and requires several specificities (large deformations, orthotropic material behaviour, local crushing, …). Furthermore, by treating the material as a solid material important information about the micromechanics is “lost”.

This presentation will show a more viable modelling methodology to simulate the deformation mechanics of fibrous materials and it is based on the use of virtual fibres. This recently developed method effectively takes the fibrous behaviour into account by modelling a yarn as a bundle of virtual fibres, see Figure 1. Each virtual fibre is modelled as a chain of truss elements in Abaqus\Explicit. The virtual fibres can realign themselves and slide relative to each other resembling the mechanics in a real yarn. The advantages of this method will be illustrated by applying it to some very complex problems such as the mechanical behaviour of 3D woven fabrics, draping behaviour of fabrics and stitching of sandwich panels.

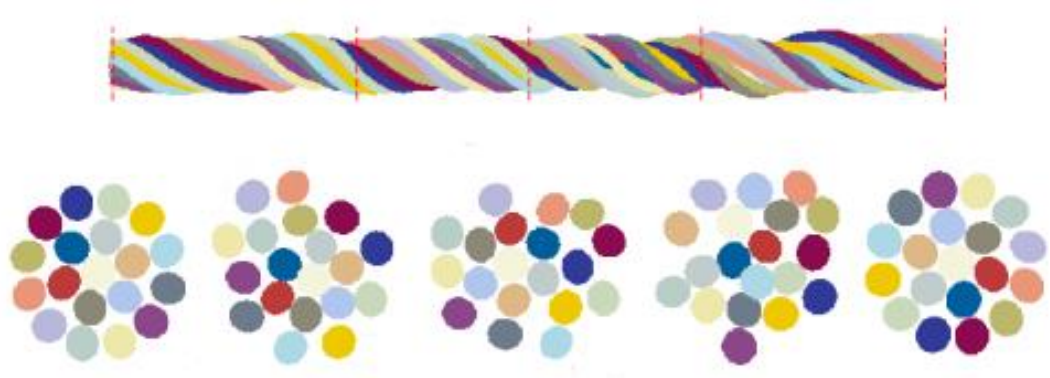

Figure 1: The twisting of a textile yarn simulated by discretizing the yarn into 19 virtual fibres and applying twist on the yarn ends shows that the modelling method captures the fibrous behaviour in a natural manner.