A discrete element approach for modeling the processing of fibrous biomass

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ABSTRACT

Simulations are becoming increasingly important for the optimization of various processes. However, in the case of biomass handling the natural variability of the biological material adds an extra challenge. As the processing of crop stems is governed by the discrete interactions between the particles and the machine parts, bulk models are inadequate to properly describe the crop-machine interaction for low and moderate particle densities.

Discrete element modeling (DEM) has been proposed as a better way to model the behavior of particulate systems (Tijskens et al., 2003). While DEM has already been successfully applied for modeling grain and fertilizer streams (Van Liedekerke et al, 2009). Recently, its usefulness for simulating the flow and compression of flexible stems has also been demonstrated (Lenaerts et al., 2014). However, while the linear elastic and Hertzian contact models can describe the reversible bending and compression of crop stems in a realistic way for small deformations, they are inadequate for describing the behavior at higher forces where buckling phenomena become important (Leblicq et al., 2015). Therefore, the aim of this study was to implement and test data based models for the buckling behavior of crop stems during bending and compression in DEM simulations. In this way, the decrease in deformation resistance with increasing damage is also taken into account. Using these models virtual, bendable crop stems, with a realistic geometry, were created in the DEMeter++ software. The virtual stems were used to simulate the compression of wheat straw in a compression box. This calibrated DEM model will, in future research, be used to simulate the processing of crop stems by harvest and post-harvest machinery.

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