Title The simulation of the impact damage to fruit during the passage of a truck over a speed bump by means of the discrete element method

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Citation Biosystems Engineering, Volume 101, Issue 1, September 2008, Pages 58-68

Keywords impact damage; fruit; speed bump; discrete element method

Abstract

The discrete element method (DEM) was used to study fruit damage during transportation. The DEM is a particle-based simulation technique which is well suited for the solution of granular material related problems in food and agriculture. In this paper, the application of DEM to food transport problems was demonstrated by simulation of bruising to apples stored in bulk bins during the passage of a truck over a speed bump. The effects of truck load, bulk bin position, suspension type and driving speed on damage were investigated. The simulations showed that higher truck loads lead to less bruising and that apples in bulk bins behind the rear axle suffered more damage than those in bulk bins in front of the rear axle. Furthermore, a considerable reduction in the damage was predicted in simulations where the truck has a soft suspension. Independent of truck load, suspension type and bulk bin position, the commercially significant bruising (i.e. apples with bruise volume of maximum bruise above 500 mm^3) was predicted to be insignificant for driving speeds below 20 km h^{-1}. At higher driving speeds, the extent of commercially acceptable bruising depended on various parameters. A reduction in the driving speed, an increase in the truck load and a reduction in the suspension stiffness all helped to reduce the occurrence of fruit damage.