Title: A comparison between two approaches in modeling the multi-layered composite structure of a rolling truck tire using LS-DYNA

Keywords: Rolling truck tire model; multi-layered composite structure; dynamic tire properties; finite element; LS-DYNA; PART_COMPOSITE

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Abstract: Accurate modeling of a truck tire for predicting its dynamic characteristics requires an adequate representation of its composite plies. This study compares two approaches in modeling the multi-layered structure of a rolling radial-ply truck tire using LS-DYNA. In the first approach, each layer in the tire structure is modeled by a separate element; whereas, in the second, all layers are represented by a single element with layered configuration managed by the PART_COMPOSITE keyword. The first model consists of a detailed representation of the tire structure, where the carcass and belt plies are formulated using layers of isotropic solids representing rubber matrix, together with separate layers of orthotropic shells describing fiber-reinforced composite plies. The validity of the first model is then demonstrated by comparing the predicted load-deflection, cornering force/moment, and free vertical vibration characteristics with the reported experimental results. The detailed model has the potential to be applied as an accurate virtual tool to study the influences of various operating and design parameters upon the tire dynamic characteristics. However, the large number of elements in such a comprehensive model makes it computationally expensive. In the second model, the carcass and belt plies are represented using a single layer of shell elements with layered configuration. In this approach, stacks of plies with pertinent material properties, thicknesses and fiber orientations are defined inside one single composite part made of layered shell elements. The simplified model was then evaluated through comparing the simulation results with those of the detailed model and showed reasonable agreement. With the simplified model, the computational efficiency was remarkably improved since defining several layers inside one layered element reduced the number of elements and thus the computational demand.