Simulating anisotropy with Ls-dyna in glass-reinforced, polypropylene-based components

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Abstract:

Glass-fiber-reinforced polypropylene (GF PP) materials are increasingly being used by customers to replace metal and engineering polymers in structural automotive applications. Like all glass-fiber-reinforced thermoplastics, GF PP products can show anisotropy caused by fiber orientation that is induced by the injection process. Taking into account fiber orientation in the simulations enables designers to improve the accuracy of the analyses. This can help prevent arbitrary choices and assumptions when setting material parameters, which become mandatory when an isotropic material law is used. The method proposed in this paper takes advantage of the availability within Ls-dyna of an anisotropic material law (MAT_103), which allows simplified modeling to address critical issues. This law was not developed to address the problem discussed here. Therefore, this paper illustrates a simplified approach. The presence of glass reinforced fibers is taken into account by running a mold-filling analysis, and then transferring the material flow orientation in to the structural simulation as a material angle. The dependence of the material failure strain on the material orientation can be also easily modeled through a user subroutine. Finally, the approach only requires simple material data based on basic tensile tests; the material law parameters are then identified through optimization techniques. Although this approach is based on some simplifying assumptions, its application is quick and can help the designer obtain more accurate results with respect to the traditional isotropic approach. A selection of validation tests is then proposed that show reliable predictions using limited additional computational effort.