We study the application of the QR decomposition in the theory of Green elastic solids with emphasis on transversely isotropic materials such as fiber-reinforced materials. We provide a methodology, how to use the QR decomposition to describe materials with general fiber orientation including curved fibers. We then focus on the so-called conjugate stress / strain basis model, and we show that for isotropic materials the model is equivalent to the standard model of Green elastic solid. We also provide a methodology, how to describe transversely isotropic materials using the QR decomposition. Next, we consider the popular standard reinforcing material model with spatially-varying fiber directions and fiber stiffnesses, and we perform numerical experiments in various geometries. To our best knowledge, our implementation is the first implementation of numerical solvers for QR based models with spatially-varying fiber directions. Finally, we compare the results for the conjugate stress / strain model with the results for the standard model of Green elasticity and linear elasticity.