A Phenomenological Model for the Adaptative Biomechanical Response of Growing Tree

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Modelling the shape evolution of growing trees requires to account for the interaction between growth and adaptative biomechanical response to its environment. Trees develop growth strategies to ensure light and nutrient capture as stability. These strategies are linked with the branching process and shape evolution of the exisiting branches or stem. Unlike growth of bones and soft tissues where the change in volume originates from the insertion of new particles within the continuum, growth in trees is modeled by the addition of new material points on an existing deformed structure. Most of the existing models adopt an incremental approach and propose the equilibrium of the growing structure to be reached at each time t after growth has occured, thus separating growth and mechanical effects. Guillon *et al.* ([1, 2]) have origninally proposed a new formalism to model the time-space continuous growth of rod with applications to tree-like structures. The purpose of this work is to advance some thermodynamically consistent constitutive relations describing the biomechanical response of the continuously radially growing section. In particular, we introduce an internal variable which aims at accounting for the adaptative structure of the (growing) woody stem section. We present an existence analysis for both the constitutive relation problem and the quasi-static evolution problem.

References

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