



DIPARTIMENTO INGEGNERIA CIVILE-INDUSTRIALE E ARCHITETTURA
UNIVERSITÀ DEGLI STUDI DI CATANIA
PHD PROGRAM IN DEFENSE AGAINST NATURAL RISKS
AND ECOLOGICAL TRANSITION OF THE BUILT ENVIRONMENT

PhD Program of National Interest "Defense against natural risks and ecological transition of the built environment"

Wednesday 14 Oct 2026 room P7 (Ed. Polifunzionale) at 14:00-15:00

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Title of the Seminar

Configurational Mechanics of Muscle Contraction

Continuum mechanical models of skeletal muscle contraction describe the bulk behaviour of the tissue, and use either an additive decomposition of the stress or a multiplicative decomposition of the deformation gradient. We propose a novel approach, based on the combination of the multiplicative decomposition of the deformation **Errore. L'origine riferimento non è stata trovata.**, and the Fenton-Karma model of muscle electrophysiology.

The deformation gradient is multiplicatively decomposed into active (anelastic) and elastic distortions, as Both distortions are imposed to be isochoric (i.e., volume-preserving): the passive (elastic) behaviour of soft tissues is known to be incompressible, and the active (anelastic) contraction of muscle is known to be isochoric. The motion and the active part of the deformation gradient are regarded as the standard and configurational kinematical descriptors, respectively. The balance equations are obtained via the principle of virtual work for constrained systems. Under the hypothesis of hyperelastic behaviour, the non-reactive first Piola stress is obtained from the Helmholtz free energy. The dissipative part of the non-reactive internal configurational force is assumed to be proportional to the anelastic distortion rate. The external configurational force, representing muscle activation, is expressed in terms of calcium concentration, which is in turn a function of the electrophysiological potentials in the muscle. The model correctly predicts isometric (constant length) and isotonic (constant force) muscle contraction, as well as the classical force-length relationship.

Biography

Salvatore Federico received his Laurea in Mechanical Engineering in 2000 and his PhD in Structural Mechanics in 2004 from the University of Catania (Italy). In 2005, he joined the University of Calgary (Canada), where he has been a post-doctoral fellow in the Human Performance Laboratory (2005-2007) and subsequently a faculty member in the Department of Mechanical and Manufacturing Engineering and the Department of Biomedical Engineering (2008-present), with an adjunct position in Kinesiology, Human Performance Laboratory (2012-present). In June 2021, he received a Bachelor of Arts in Greek and Roman Studies from the University of Calgary. He teaches Mechanics of Solids, Biomechanics and Continuum Mechanics, and his research focuses on the mathematical and geometrical foundations of Continuum Mechanics and its applications to non-linear elasticity, porous materials, materials with coupled mechanical and electromagnetic properties and soft tissue biomechanics.