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On the measure of shear at large strains

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Several works about the notion of "pure shear" in the framework of hyperelasticity appeared in the Literature over time, many of them recently, even though this is a classic topic in elastostatics. This is because different interpretations about "pure shear" are possible when large deformations occur. Indeed, conversely to the infinitesimal elasticity, it easy to show that a state of *pure shear stress* does not correspond to a state of *pure shear deformation,* unless a series of important restrictions about the stress response function of the material are assumed [1]. Two popular schemes known as "simple shear" and "pure shear" are usually adopted to try to describe the shar response of a hyperelastic material. Despite the terminology, both these layouts involve also normal stress components, and, above all, their kinematics significantly differ from each other. As a consequence, different results are obtained when such layouts are used to characterize the constitutive law of a material, thus leading to ambiguities [2].
Inspired by the notion of angular variation at large strains, we have proposed an alternative homogeneous kinematic layout in a 2D setting. Conversely to the aforementioned ones, in compliance with a real pure shear deformation condition, this scheme is characterized by zero in-plane diagonal components of the Green-St.Venant strain tensor [3]. This is achieved by imposing a relationship between the in-plane principal stretches such as to preserve the length of the fibers along the boundaries of the system.
An experimental equipment reproducing accurately the kinematical model has been realized also, thus making it possible to test rubberlike materials subjected to large shear deformations. An extension of the theoretical model to the 3D framework has been provided too.

Keywords: simple shear; pure shear; angular shear; finite elasticity.

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