DEPARTMENT
CIVIL, CHEMICAL, ENVIRONMENTAL, AND MATERIALS ENGINEERING - DICAM

PhD @ DICAM Seminar

"I limiti e le sfide della Scienza delle Costruzioni: the folding of an elastic continuum, the torsional gun, and the dripping of an elastic rod"

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Materials with extreme mechanical anisotropy are designed to work near a material instability threshold where they display stress channelling and strain localization, effects that can be exploited in several technologies.

The antiplane strain Green's functions for an applied concentrated force and moment are obtained for Cosserat elastic solids with extreme anisotropy, which can be tailored to bring the material in a state close to an instability threshold such as failure of ellipticity. These Green's functions are used as perturbing agents to demonstrate in an extreme material the emergence of localized stress channelling and the emergence of antiplane localized folding and faulting of a Cosserat continuum, phenomena which remain excluded for a Cauchy elastic material. During folding some components of the displacement gradient suffer a finite jump, whereas during faulting the displacement itself displays a finite discontinuity [1, 2].

Configurational forces occur in all situations where a solid body can change configuration through a release of energy. Examples of these forces are the Peach-Koehler interactions between dislocations or the forces acting on a phase boundary during phase transformations. Speaking of elastic structures, is it possible to find configurational forces acting on these? Theoretical and experimental proofs of the existence of these forces have been recently given [3].

Once discovered, we have been able to design systems exhibiting various configurational forces. These are shown to deeply influence stability [4] and have inspired us the design of a new type of scale, in which both equilibrium (as in a rigid arm balance) and deformation (as in a spring balance) determine the solution of a highly nonlinear system that can be calculated and realized to measure weight [5].

Configurational forces can also be induced by torsion, a concept which has inspired to us the idea of a new type of torsional actuator, nicknamed 'torsional gun' [6].

Finally, since the Euler's differential equation of the elastica governs an oscillating pendulum, a buckling rod, and a pendant drop, we have posed and solved [7] the problem of the dripping of an elastic rod, namely: can an elastic rod subject to a transversal force self-encapsulate and take the shape of a drop?

References

[1] P.A. Gourgiotis and D. Bigoni, Stress channelling in extreme couple-stress materials Part I: Strong ellipticity, wave propagation, ellipticity, and discontinuity relations. J. Mech. Phys. Solids. In press.

[2] P.A. Gourgiotis and D. Bigoni, Stress channelling in extreme couple-stress materials Part II: Localized folding vs faulting of a continuum in single and cross geometries. J. Mech. Phys. Solids. In press.

[3] D. Bigoni, F. Dal Corso, F. Bosi and D. Misseroni, Eshelby-like forces acting on elastic structures: theoretical and experimental proof. Mech. Materials, 2015, 80, 368–374.

[4] D. Bigoni, F. Bosi, F. Dal Corso and D. Misseroni, Instability of a penetrating blade. J. Mech. Phys. Solids, 2014, 64, 411-425.

[5] F. Bosi, F. Dal Corso, D. Misseroni and D. Bigoni An elastica arm scale. Proc. Royal Soc. A, 2014, 470.

[6] D. Bigoni, F. Dal Corso, D.Misseroni and F. Bosi, Torsional locomotion. Proc. Royal Soc. A, 2014, 20140599.

[7] F. Bosi, D. Misseroni, F. Dal Corso, and D. Bigoni, Self-encapsulation, or the 'dripping' of an elastic rod, Proc. Royal Soc. A, 2015, 471, 20150195.

Short CV

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