



Dipartimento
Meccanica
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Dipartimento
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2018-2022
2023-2027

CALL FOR EXPRESSION OF INTEREST FOR MSCA POSTDOCTORAL FELLOWSHIPS AT POLITECNICO DI BARI

Research project

Nome and Surname: Prof. Nicola Menga, Prof. Luciano Afferrante

Title: Finite-strains adhesive and frictional contact mechanics

Description:

From Hertz's pioneering work in 1882 to recent advancements in the field, contact mechanics has traditionally relied on the strong assumptions of linear elasticity. However, experiments involving materials that undergo large deformations, such as rubbers and elastomers, are hard to be described within this framework based on small strain and displacement, especially when frictional slip occurs [1-3]. In such cases, it has been proved that move beyond linear elasticity is essential to account for geometric and material nonlinearity [4]. Despite efforts to develop numerical tools capable of incorporating these features in contact problems [5], our understanding of their actual impact remains limited.

Recent studies have shown that these effects might significantly alter the systems response [6-8], even in a counterintuitive manner (e.g., contact area variation, friction enhancement, hysteresis, etc.); however, the investigation is case-sensitive and still focus on very simple geometries (Hertzian, sinusoidal, peeling), eventually being of limited practical interest.

The objective of this project is to develop a numerical tool to investigate the role of finite elasticity on the contact response of real (rough) interfaces, eventually accounting for fundamental phenomena such as friction and adhesion. In the framework of innovative FEM calculations simplified to deal with multi-asperity conditions, finite range adhesion (as well as infinitely short range) and different local friction models will be implemented.

The expected outcomes will allow for a critical understanding of the interfacial response in real applications governed by system nonlinearity, thus well beyond the current state of the art relying on linear theory.

References:

- [1] Chateauminois A, Fretigny C. Local friction at a sliding interface between an elastomer and a rigid spherical probe. *Eur Phys J E* 2008;27:221–7.
- [2] Nguyen DT, Paolino P, Audry M, Chateauminois A, Fretigny C, Le Chenadec Y, Portigliatti M, Barthel E. Surface pressure and shear stress fields within a frictional contact on rubber. *J Adhes* 2011;87(3):235–50.



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- [3] Mergel JC, Scheibert J, Sauer RA. Contact with coupled adhesion and friction: Computational framework, applications, and new insights. *J Mech Phys Solids* 2021;146:104194.
- [4] Lengiewicz J, de Souza M, Lahmar MA, Courbon C, Dalmas D, Stupkiewicz S, Scheibert J. Finite deformations govern the anisotropic shear-induced area reduction of soft elastic contacts. *J Mech Phys Solids* 2020;143:104056.
- [5] Wriggers P, Rust WT. A virtual element method for frictional contact including large deformations. *Eng Comput* 2019;36(7):2133–61.
- [6] Scaraggi M, Comingio D, Al-Qudsi A, De Lorenzis L. The influence of geometrical and rheological non-linearity on the calculation of rubber friction. *Tribol Int* 2016;101:402–13.
- [7] Begley MR, Collino RR, Israelachvili JN, McMeeking RM. Peeling of a tape with large deformations and frictional sliding. *J Mech Phys Solids* 2013;61(5):1265–79. <http://dx.doi.org/10.1016/j.jmps.2012.09.014>.
- [8] Ceglie, M., Violano, G., Afferrante, L., & Menga, N. (2025). Finite deformations induce friction hysteresis in normal wavy contacts. *International Journal of Mechanical Sciences*, 291, 110115.

Candidates should provide detailed CV

Candidates must be eligible according to the criteria established by the 2026 MSCA Postdoctoral fellowship call:

- to have a PhD by the call deadline.
- to have up to 8 years of research experience after PhD.
- to be citizens of an EU State or of an Associated Country.
- not to have resided or carried out their main activity in Italy for more than 12 months in the 36 months before the call deadline.

Contacts

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