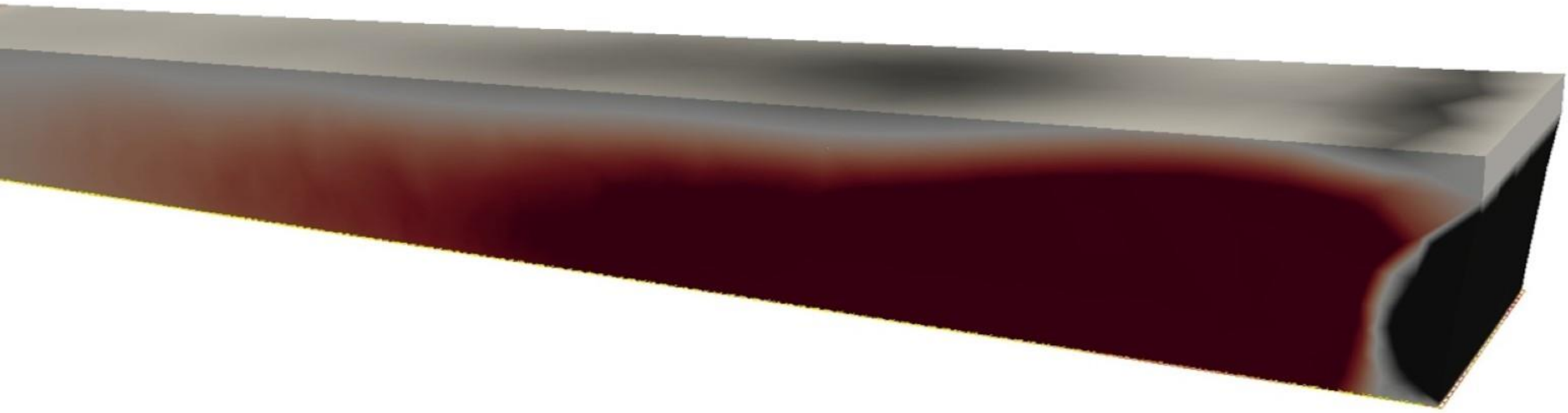


Finite Element Modeling of the Detachment of Soft Adhesives

Stick-slip phenomena and Schallamach waves captured using reversible cohesive elements

Evelyne Ringoot et al. *Stick-slip phenomena and Schallamach waves captured using reversible cohesive elements*. 2020. arXiv: 2011.13051 [cond-mat.soft].

Evelyne Ringoot

- BSc in Engineering Sciences at VUB Brussels 2018
- Msc in Civil Engineering at VUB Brussels 2020
    - Specialization in geomechanics and numerical methods
- Visiting Student at École polytechnique fédérale de Lausanne
- Visiting Student at Massachusetts Institute of Technology

Soft Adhesives

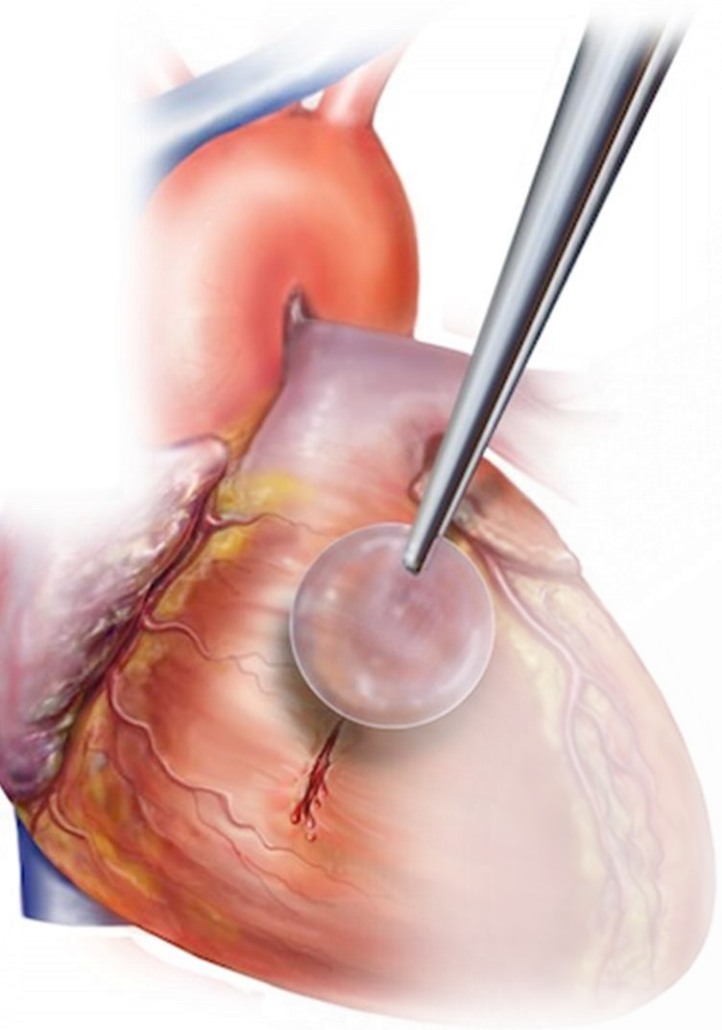
And the remarkable reversible capacities of natural adhesives

How to explain reattachment and reversible adhesion?

Stefan Sirucek (2014) How gecko's turn their stickiness on and off in 'National Geographic'.

Soft Adhesive Applications

Medical: tissue repair, wound scaffolds or drug patches

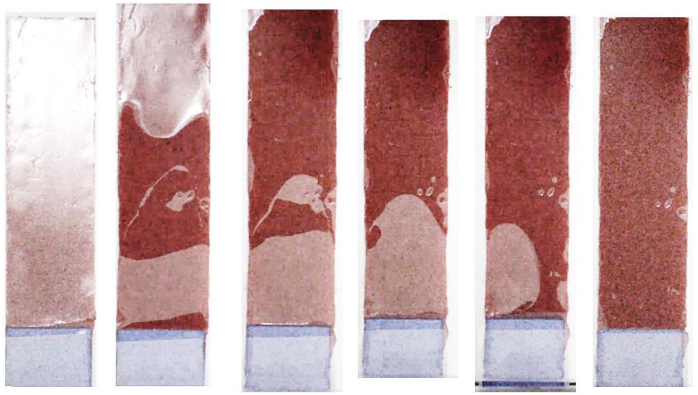


High-precision non-damaging soft grippers

Climbing robots for dangerous environments

UC San Diego Jacobs School of Engineering (2018), Tolley Gecko Gripper on Flickr, consulted in Sept 2020 on https://www.flickr.com/photos/jsoe/albums/72157695462669655/with/40449351705/
The European Space Agency (2014), Wall-crawling gecko robots can stick in space too, consulted in Sept 2020 http://www.esa.int/Enabling_Support/Space_Engineering_Technology/Wall-crawling_gecko_robots_can_stick_in_space_too
The Karplab (2014), Worm-Inspired Glue Mends Broken Hearts, consulted on Sept 2020 on https://www.karplab.net/portfolio-item/worm-inspired-glue-mends-broken-hearts

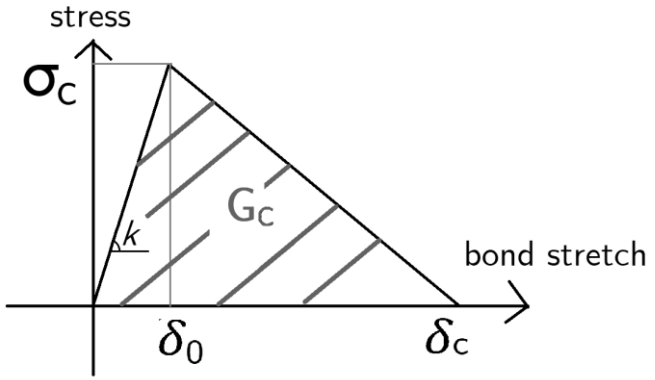
Experimental observations



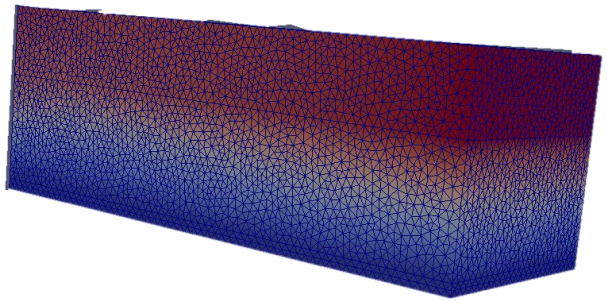
Research questions in mechanics of solids: how to explain, predict and influence physical realities?

Analytical theory

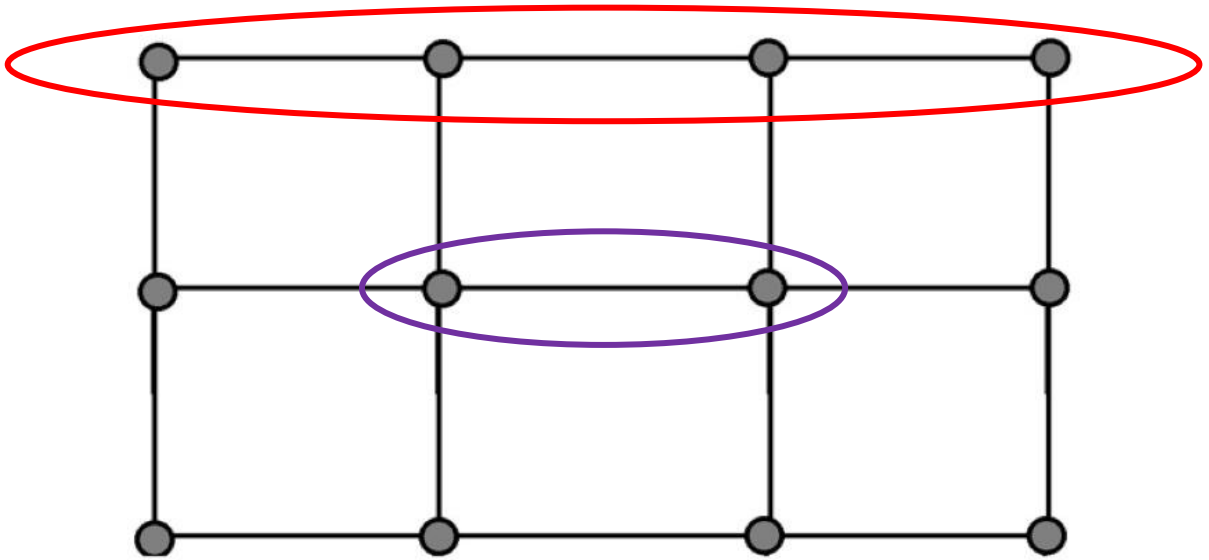
Cohesive elements represent surface strength assumptions



Numerical solutions



Finite Element Models of solid deformation



Differential equations governing the conservation of mass and momentum:

$$\dot{\rho} + \rho \operatorname{div} \mathbf{v} = 0$$

$$\operatorname{div} \mathbf{T} + \rho \mathbf{b} = \rho \dot{\mathbf{v}},$$

$$\mathbf{T} = \mathbf{T}^T$$

+ constitutive equations linking stress induced by forces to strain encountered by the material

+Boundary conditions on the stress or strain state applied on the borders of the material

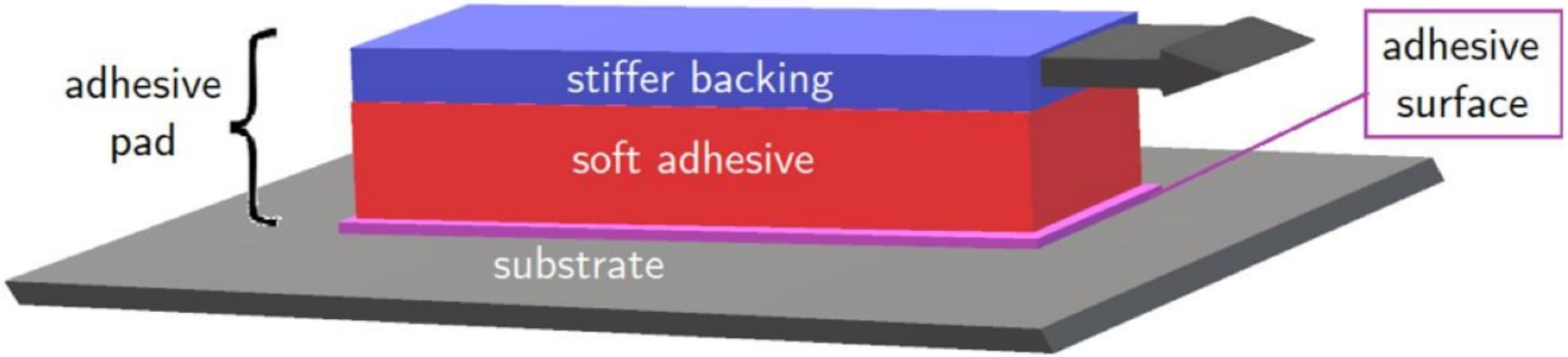
Commercial Finite Element Models software

ANSYS

ABAQUS

NX NASTRAN

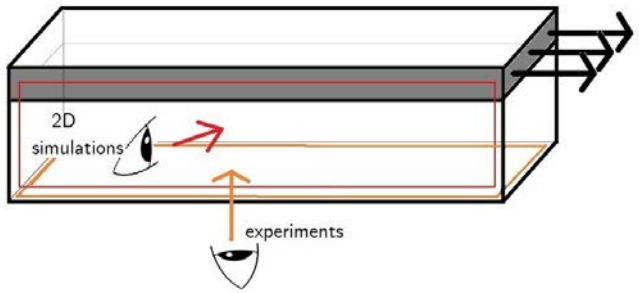
Or code developed in research groups: Akantu



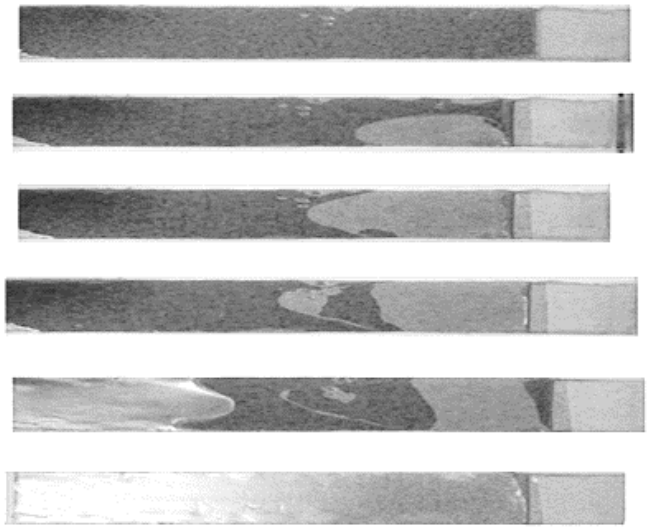
The detachment and re-attachment of adhesive with multiple layers when loaded parallel to their substrate

Evelyne Ringoot et al. *Stick-slip phenomena and Schallamach waves captured using reversible cohesive elements*. 2020. arXiv: 2011.13051 [cond-mat.soft].

Adapting a FEM framework allowed to numerically replicate a physical phenomena that is still not fully understood: Soft Adhesive detachment



Experiment



Simulation

Attached Detached

Attached Detached

18.085 Computational Science and Engineering I
Summer 2020