Friction mechanisms of water-rubber multi-asperity interfaces

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Abstract

Many mechanical systems involve water-rubber interfaces such as joints sealing, tire/road or wiper blade/windscreen contacts. Their friction mechanisms rises from the combining three major sources which relative contribution depends on the environment of the contact and the water phases:
- The proper viscoelastic dissipation of the rubber itself ;

- The adhesive nature of the contact which is governed both by the molecular structure and the surfaces roughness ;

- The dynamics of the multi-asperity interface.

In this framework, the challenge is the investigation of the water-rubber interfaces over a macroscopic scale that covers a sufficient amount of contact spots in order to develop a statistical approach. In this talk, the latter is highlighted through two particular examples:

- The stick-slip of an elastomer/glass contact immersed in liquid water : thanks to a model, based on a single degree-of-freedom mass-spring-damper oscillator we defined a stability criterion combining on the elastomer intrinsic material damping and the friction-velocity dependence. The origin of the instability is explained the physical nature of the contact spots in which we pointed out the prior importance of adhesion capillary forces. A friction law based on the surface topography analysis of the rubber has been established ;
- The unexpected coupling between adhesion, elastomer viscoelasticity and thermal effects in the frictional behavior of an ice/rubber contact: thanks to a in situ contact area measurements, a dimensionless friction master curve was obtained with the sliding velocity, regardless of the temperature and the material properties. A predictive friction model was proposed to explain the bell-shape friction-velocity curve for which the classical WLF transform is not relevant.

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