Advancing Parameter Extraction in Adhesive Contact Mechanics: A Method for Estimating the Tabor Parameter Across Adhesive Regimes

D. Dalmas and J. Scheibert

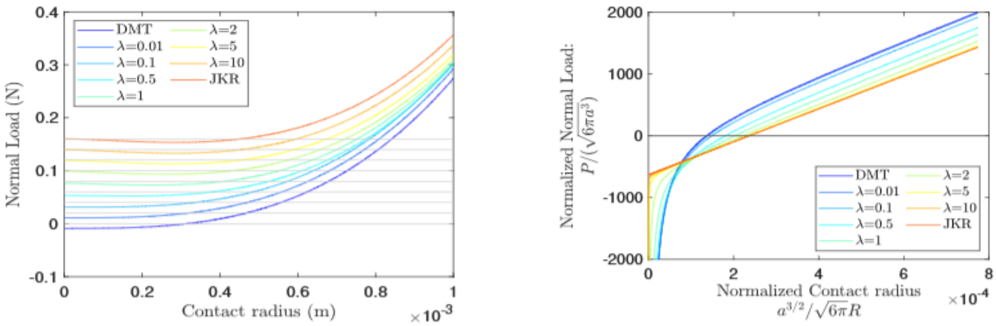
CNRS, Ecole Centrale de Lyon, ENTPE, LTDS, UMR 5513, Ecully,69130, France.

The accurate extraction of material parameters from contact experiments is a cornerstone of adhesive contact mechanics, enabling the quantitative comparison between theoretical models and experimental data. Among these parameters, the Tabor parameter (λ) is particularly critical, as it governs the transition between adhesion models, from DMT-like ($\lambda \to 0$) to JKR-like ($\lambda \to +\infty$) behaviors (Figure). However, traditional fitting methods often fail to capture the full spectrum of λ.

In this work, we identify an efficient fitting methodology to extract material parameters from sphere-plane contact data Our approach leverages the Maugis-Dugdale [1] model but is performed on normalized data, following the normalization proposed by Chaudhury et al. [2] (panel b of Figure). To validate its performance, we generated theoretical datasets simulating the evolution of contact area vs normal force for various combinations of sphere radius, Young's moduli and adhesion energies.

Our results demonstrate that our method outperforms established literature-proposed methods (DMT, JKR, Carpick et al. [3] or Chaudhury et al. [2]). The method's reliability is further confirmed under more experimentally realistic conditions by adding measurement noise. A key insight from this study is the importance of collecting data at the smallest possible contact radii, as these measurements are critical for precise λ estimation.

This work not only advances the accuracy of parameter extraction in contact mechanics but also highlights the necessity of careful data acquisition. By providing a more versatile and precise tool for parameter estimation, our method contributes to refining predictive models in tribology and contact mechanics.



(a) (b)

Figure 1: (a) Normal load as a function of the contact radius for DMT model, MD model with different λ ranging from 0.01 to 10 and JKR. Each curve is vertically offset by 0.02 for clarity. The system parameters are typical of a centimetric soft elastomer sphere. (b) The same data plotted using the normalization method proposed by Chaudhury et al. [2].

References

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