Universality of Greenwood-Williamson contact mechanics

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In this contribution, computer-generated randomly rough surfaces showing an intermediate Gaussian distribution of heights are considered for determining universally valid features of the classical Greenwood-Williamson contact mechanics.

Keywords: contact mechanics, modelling, intermediate Gaussian distribution, Hilbert-curve

1. Introduction

On the path opened by the Hertzian contact model [1], the next highlight in contact mechanics is that provided by Greenwood and Williamson (GW) [2], which even after more than fifty years it is still the most popular and widely used one [3]. In addition to direct tribological applications, this GW-model is also well suited to estimate the electrical properties of contacting surfaces.

2. Numerical scheme

Originally, in Ref. 2 only two specific cases of the height distributions shown also in Fig. 1, namely the Gaussian and the exponential, were explicitly considered. Here, the intermediate Gaussian height distribution is used because it has among others also the advantage that its so-called roughness exponent α allows a continuous transition between the limiting cases from the original GW-model, down to a Heaviside-shape. Furthermore, for this intermediate Gaussian height distribution, one can even derive a compact, analytical GW-type formula for any contact quantity of interest, see for example in Fig. 2.

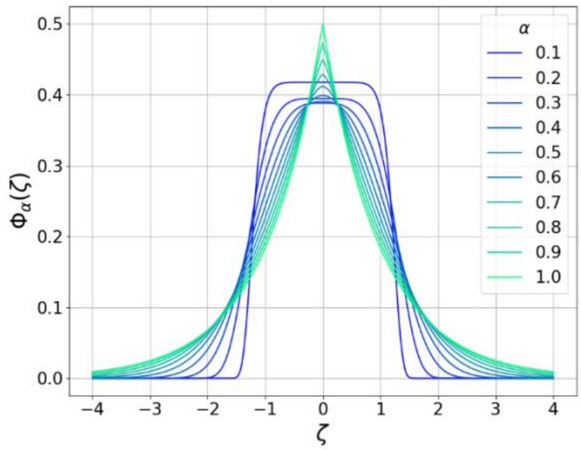

Figure 1: Distribution of heights continuously changing from an almost Heavide-shape (α → 0) via a Gaussian (α = 0.5) to an exponential form (α = 1.0).

3. Results and discussion

Once the heights are generated in accordance with a distribution from Fig. 1, these are distributed laterally following a Hilbert-curve of given order n. The n-dependence of those roughness parameters which are parametrizing the reference values of contact quantities, e.g. , A_{ref} and L_{ref} in Fig. 2, is then determined by spectral analysing each computed-generated rough surface.

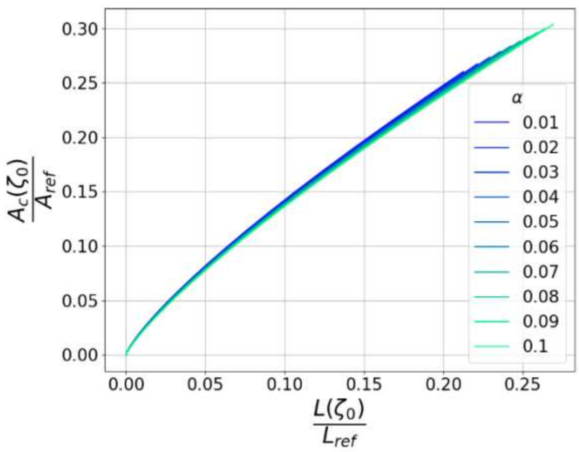

Figure 2: Dimensionless real contact area versus the dimensionless load for all height distribution from Fig. 1.

Finally, all generated randomly rough surfaces are taken as input for contact mechanics calculations performed by applying a conjugate-gradient implementation of the well-known boundary element method (BEM), with the ultimate goal to figure out the impact of the lateral distribution of heights compared to the GW-type results. In the near future, these results will be used for the performance optimization of electrochemical devices.

4. Acknowledgments

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5. References

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