Discrete Convolution and FFT with Summation of Influence Coefficients (DCS-FFT) for Three-Dimensional Periodic Contact Problems

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Many contact problems must be treated as periodic problems, such as the contact of cylinders with rough surfaces and inhomogeneities in the materials, whose structural feature in contact is confined in a finite domain in one direction but extended infinitely in the other direction. Reported in this presentation is a novel numerical model for simulating the contact involving machined cylindrical components containing inhomogeneities. Due to the stochastic nature of asperity and inhomogeneity distributions, the cylinder is divided into N number of segments in the length direction while taking the roughness and inhomogeneities in one such segment as representatives. Following the suggestions by Liu et al, the periodic convolution is used in the length direction, together with superposing the influence coefficients (ICs) from the N segments, while the cyclic convolution is used in the non-periodic direction; the solution is processed through Fast Fourier transform and the method is named DCS-FFT. The accuracy of the DCS-FFT algorithm is examined by comparison of the numerical results for a cylindrical contact with the corresponding analytical solution, and its efficiency is compared with that of two other FFT-based algorithms. The developed method is implemented to study the influence of inhomogeneities on subsurface stress distributions with/without the periodic length-direction extension and superposition of inhomogeneity ICs. A criterion is provided to decide whether the DCS is needed for the inhomogeneity IC treatment.