

Zh. Ghoreishi and D. Jalali –Vahid

Sahand University of Technology, Department. of Mechanical Engineering

Abstract - FFT techniques were employed to develop a full numerical solution for analyzing the elastic dry contact of two flat rough surfaces. The study of the quality of surfaces produced by different production methods required the simulation of the roughness of contacting surfaces and also the kind of contact. By assuming that the roughness and distribution of the contacting surfaces were random and Gaussian, the FFT method was used to simulate them. Considering the penetration of asperities of contacting surfaces to each other, parameters such as pressure distribution, surface deflection, real contact area, its distribution as well as mean pressure on the surface were computed. The effect of simulated surface specifications such as average roughness R_{a} , correlation length β^{*} and the amount of equivalent modulus of elasticity on average pressure and real contacting area was investigated. A comparison was carried out to evaluate the results. Finally, it was found that FFT techniques for solving surface and contact simulation problems were rapid and time-saving with accurate results.

Keywords: Contact, Roughness, Gaussian distribution, Real contact area, Fast Fourier Transforms

FFT

()



.[]

$$\delta_{e}(k,l) = \frac{2}{\pi E'} \sum_{j=1}^{n_{x}} \sum_{i=1}^{n_{y}} p_{i,j} D_{m,n} \qquad ()$$

$$m = |k-i+1| \quad and \quad n = |l-j+1|$$

$$E' \quad D_{m,n}$$

$$() \qquad .$$



FFT
$$c[D]\{p\} = \{\delta_{i}\}, c = \frac{2}{\pi E'}$$
 ()
FFT
()
 $() () ()$
 $\delta_{i}(x,y) = \frac{2}{\pi E} p(x,y)^{*} D(x,y)$ ()
 $p(x,y) = \hat{p}(f_{i},f_{j})$
 $\hat{p}(f_{i},f_{j}) \hat{D}(f_{i},f_{j}) p(x,y)^{*} D(x,y)$
 $p(x,y)^{*} D(x,y) \Rightarrow \hat{p}(f_{i},f_{j}) \hat{D}(f_{i},f_{j})$ ()
 $p(x,y)^{*} D(x,y) \Rightarrow \hat{p}(f_{i},f_{j}) \hat{D}(f_{i},f_{j})$ ()
 $() ()$
 $\hat{\delta}_{i}(f_{i},f_{j}) = \frac{2}{\pi E} \hat{p}(f_{i},f_{j}) \hat{D}(f_{i},f_{j})$ () $D_{m,n}$

IFFT









W A_n P_n

/









$R_q = 0.4 \mu m; \quad \beta^* = 0.5 \mu m; \quad A_r / A_n = 0.317; \quad W / A_r = 1024 MPa$







_

.



•

.

- Y. Ju and T. N. Farris, Spectral analysis of tow-dimensional contact problem, ASME Journal of Tribology, 118(1996)320-328.
- T. Nogi and T. Kato, Influence of hard surface layer on the limit of elastic contact-part 1: analysis using a real surface method, ASME Journal of Tribology, 119(1997)493-500.
- 9. A. Xiaolan and K. Sawamiphakdi, Solving elastic contact between rough surfaces as an unconstrained strain energy minimization by using CGM and FFT techniques, Journal of Tribology, 121(1999)639-647.
- 10. J. Yongqing and Zh. Linqing, A full numerical solution for the elastic contact of three-dimensional real rough surface, Wear, 157(1992)151-161.
- K. L. Johnson, Contact Machanics, Cambridge University Press, (1985)265-280.
- 12. M. Maria, M. H. Yu and B. Bhushan, Contact analysis of three-dimensional rough surfaces under frictional contact, Wear, 200 (1996) 265-280.

- J. A. Schey, Surface roughness effect in metalworking lubrication, Lubric. Engineer, 39(1983)376-382.
- 2 J. A. Greenwood and J. B. Williamson, *Contact of nominally flat surfaces*, Proc, Roy Soc, A295(1966)300-319.
- 3. D. J. Whitehouse and J. F. Archard, *The* properties of surfaces of significance in their contact, Proceeding of Royal Society of London, A316(1970)97-121.
- 4. H. A. Francis, *The accuracy of plan*strain models for the elastic contact of three-dimensional rough surfaces, Wear, 85(1983)239-256.
 - A. A. Lubrecht and E. Ioannides, *Afast* solution to the dry contact problem and the associated sub-surface stress field, Using Multilevel Techniques, ASME Journal of Tribology, 113(1991)128-132.
- 6. N. Ren and S. C. Lee, Contact simulation of three-dimensional rough surfaces using moving grid method, ASME Journal of Tribology, 115(1993) 597-601.