Discussion: "A Greenwood–Williamson Model of Small-Scale Friction" (Jones, R. E., 2007, ASME J. Appl. Mech., 74, pp. 31–40)

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The author is to be commended for his attempt to cope analytically with the complex problem of friction. A few comments regarding the present paper are in place. The present simplified friction model is essentially based on the 1949 Mindlin approach (see Ref. [1]). According to this concept, it is assumed that the contact area of an elastic spherical asperity is given by the frictionless Hertz solution (see Eq. (2)) and that slip of such an asperity will ensue when the average shear stress at its contact area reaches a critical value (see Eq. (6)). These simplifying assumptions may lead to some unrealistic situations where the local equivalent von Mises stress in the contact interface can exceed the yield strength of the sphere material. Additional shortcomings of the Mindlin concept is that an increase of the contact area due to the tangential load is completely excluded, and that sliding inception always occurs in the contact interface of each asperity regardless of its level of normal loading. This would contradict the well known phenomena of junction growth and material transfer, where the latter requires slip below the contact interface. In this regard, it is worthwhile mentioning a different approach to sliding inception of a single spherical asperity [2] and to modeling of static friction of contacting rough surfaces [3]. These papers are not limited to elastically deformed asperities, and in Ref. [3] adhesion effect was also considered. However, these two models still assume, like in the present paper, that the contact area resulting from a frictionless normal loading is unaffected by the additional tangential load. A more realistic model was recently presented in two papers by Brizmer et al. assuming full stick contact condition for both normal and tangential loadings (see Refs. [4,5]). The full stick contact condition captures very well the concept of an adhesive joint formed in the contact interface. It does not require simplifying assumptions regarding the size of the contact area and the location of slip at the contact interface; therefore, it never violates the von Mises yield criterion. Furthermore, it utilizes first principles to predict the sliding inception at the instant of vanishing tangential stiffness (as shown in Fig. 1 of the present paper) and to obtain the resulting corresponding static friction and junction growth. Since the full stick contact condition does not impose slip at the contact interface, it allows for the possibility of material transfer under severe normal loads. Additionally, the results of Refs. [4,5] correlate well with some preliminary experimental results obtained by Ovcharenko et al. [6].

Contributed by the Applied Mechanics Division of ASME for publication in the Journal of Applied Mechanics. Manuscript received April 9, 2007; final manuscript received September 24, 2007; published online May 15, 2008. Review conducted by Robert M. McMeeking.

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