Title: Interpreting friction behaviour through real contact area analyses

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Abstract

Today there is still a lack of understanding and primarily lack of clearly recognised and accepted mathematical description on whether friction force follows linear relation to normal load or there are more parameters needed to account for friction force, i.e. multi-term relations apply. Despite a very simple existing empirical relations, friction behaviour is a complex phenomenon. However, today we have much evidence from carefully made theoretical and experimental analyses that the above discussion could be resolved. The question is, why this issue persists and thus how to properly interpret all the insightful studies made in the past. We believe that one important reason is lack of detailed, and high-resolution analyses of real contact area for different material and surface characteristics, both under static and sliding conditions. This work discusses the early theories of friction, which still represents fundamental physical concepts for evaluating the resistance due to friction force and compares them to our own new experimental insights. We take advantage of being able to measure the real contact area with sub-micron precision in lateral and 20 nm in vertical direction and at the same time impose sliding and measure friction. In this way we can observe the effect of real contact area and real shear stress on friction of steel surfaces with various engineering-relevant surface roughness values. These analyses, combined with our earlier findings in static conditions are presented in this work.