# SHAKEDOWN AND SURFACE ENGINEERING

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ABSTRACT

When a hard rough surface slides repeatedly on a softer half-space a system of protective residual stresses may be developed in the near surface layers of the softer material which enable loads sufficiently large to cause plastic deformation in the early cycles of loading to be accommodated purely elastically in the later stages of the component life. This is the process known as shakedown and limits on the intensity of the allowable Hertzian pressures consistent with the eventual cessation of plastic deformation for uniform half-spaces are now well established. Many practical techniques of surface engineering rely on the deposition of a well-bonded hard coat on a softer substrate and, in this situation, both the elastic and plastic properties of the coating, which may consist of several layers, differ from those of the underlying material; these differences present difficulties in formulating the the corresponding shakedown limits. In addition to the values of hardness and stiffness, compared to those of the substrate, important system parameters are the thickness of the elements of the coating (in comparison to the characteristic dimension of surface roughness) the integrity of the interlayer bonds and the coefficient of friction between the coated component and the surface against which it slides.

These parameters have been varied systematically in order to study their effect on the resulting shakedown limits. The results of the study can be displayed in the form of a number of non-dimensional shakedown charts or maps which demonstrate to the materials engineer or designer the potential improvement that might accrue from optimal surface engineering. They also indicate the conditions under which, because of an excessive mismatch between the mechanical properties of the coating and the substrate, inappropriate surface treatments may lead to either no significant improvement or, in some circumstances, even a degradation in surface tribological performance.

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