

Contact Pressure for Seizure and Galling

The mean pressure for FULL plastic contact (analogous to a hardness test) is about $3Y$ where Y is the uni-axial yield stress. This is likely to be the relevant condition for junction growth, seizure and galling.

Initiation of plastic flow starts at a lower pressure and occurs when the maximum shear stress reaches the shear yield stress k for the material. The maximum shear stress in a Hertz contact is buried at $0.47a$ below the surface and is approximately $0.47 \times$ mean contact pressure. This all means that, for a Tresca material, the mean contact pressure for initiation of yield is about $1.1Y$. But note that the surface material is still elastic - there is a miniscule plastic enclave under the surface.

If we now add mechanical shear, because of sliding action, we would expect a further decrease in either the applied load or temperature at which yield occurs.

The upshot of this, is confirmation of the general pointlessness, pun intended, of running a matrix of tests with a ball on flat specimen configuration at different loads and temperatures. We learn nothing if our test simply produces the same result, regardless of test conditions, in this case a failure of our test specimens. This is equivalent to trying to run a tensile test in which we try to control the load at levels in excess of the ultimate tensile strength of the material sample; it does not matter what load we attempt to apply, we always get the same answer.

If the contacts in the real application do not involve pressures close to or in excess of the $3Y$, do not use test conditions that produce contact pressure in excess of $3Y$ in your test system. If you do choose to use test conditions that give contact pressures in excess of $3Y$, do not bother running a matrix of tests at different test conditions.

To avoid unwanted strain hardening of the surface do not run tests with contact pressures in excess of $1.1Y$. Note that with a sliding hertzian point contact, the centre of the contact will be subjected to far greater strain hardening than the edges of the contact.