Problem A shaft must transmit a torque of 1000 Nm, with superimposed torsional vibrations causing an alternating torque of 250 Nm. A safety factor of 2 should be applied to both loads.

A heat treated alloy steel is to be used, with $S_u = 1.2$GPa and $S_y = 1.0$GPa. The shaft will have a shoulder, with D/d=1.2 and r/d=0.05 as show in the diagram. A good quality commercial ground finish is to be specified, what diameter is required for infinite life?