## Roger Cortesi, 16 DEC 00

## How will the bearing rails deflect over the length of travel at maximum and minimum workpiece sizes?

$m_{spindle} := 30lb$ Mass of Spindle $GPa := 10^9 Pa$ $\mu m := 10^{-6} m$

$\rho_{Al02} := 3900 \frac{kg}{m^3}$ $D_{wp} := 15in$ $L_{wp} := 12in$ Parameters for maximum workpiece size.

$m_{wp} := \rho_{Al02} \cdot L_{wp} \cdot \frac{\pi}{4} \cdot D_{wp}^2$ $m_{wp} = 135.5\,kg$ The maximum mass of the workpiece

Dimensions and properties of bearing and rail.

$L_{brng} := 4in$ $L_{rail} := 16in$

$E := 210GPa$ $D_{rail} := 50mm$ $I := \frac{\pi \cdot D_{rail}^4}{64}$

$$\delta(F,x) := \frac{F \cdot x^3}{3 \cdot E \cdot I} \cdot \left(\frac{x - L_{rail}}{L_{rail}}\right)^3$$

The function for deflection of beam clamped at both ends at the point x. The force is also applied at x. δ is the conservative estimate assuming the whole load is applied at a single point. δ1 is a more realistic loading with the load being applied at two points.

$$\delta_1(F,x) := \frac{F}{6 \cdot E \cdot I} \cdot \left[\left(x - \frac{L_{brng}}{2}\right)^3 \cdot \left(\frac{x - L_{brng} \cdot 0.5 - L_{rail}}{L_{rail}}\right)^3 + \left(x + \frac{L_{brng}}{2}\right)^3 \cdot \left(\frac{x + L_{brng} \cdot 0.5 - L_{rail}}{L_{rail}}\right)^3\right]$$

$F_{max} := 0.25 \cdot (m_{spindle} + m_{wp}) \cdot g$

$F_{min} := 0.25 \cdot m_{spindle} \cdot g$

The maximum and minimum forces applied to the carriage. The are divided by four because four rails will be supporting the carriage.

$\delta(F_{max}, 0.5 \cdot L_{rail}) = -2\,\mu m$

$\delta_1(F_{max}, 0.5 \cdot L_{rail}) = -1.6\,\mu m$

The maximum rail deflection at the center of the rail for the single and pair point loading of the rails.