$$a^2 = a_t^2 + a_c^2 \leqslant a_m^2$$

$$a_t^2 + \frac{f^4}{r^2} = a_t^2 + \frac{a_t^4 t^4}{r^2} \leqslant a_m^2$$

$$a_t = a_m/2$$

$$\frac{a_m^2}{4} + \frac{a_m^4 t}{16 r^2} \leqslant a_m^2$$

$$\frac{a_m^4 t^4}{r^2} \leqslant 12 a_m^2$$

$$t \leqslant \left(\frac{12 r^2}{a_m^2}\right)^{1/4}$$

$$f_{\max} = \frac{a_m}{2}\left(\frac{12 r^2}{a_m^2}\right)^{1/4} = \left(\frac{3}{4} a_m^2 r^2\right)^{1/4}$$