Due Wednesday March 13

A circular tunnel of radius a is located at a depth z in a hydrostatic *in situ* stress field of magnitude γz. The tunnel lining is modeled as a ring of concrete of uniform thickness, t. The Young's modulus and Poisson's ratio of the rock are defined as E_r and ν_r, and those of the concrete are defined as E_c and ν_c. There is no separation between the concrete and the rock.

a) Derive the analytical expression for the tangential stress σ_θ on the inner surface of the concrete lining (r=a-t). That stress component is compressive but must not exceed the unconfined compressive strength of the concrete defined as σ_c. Let SF = σ_c/σ_θ be the safety factor against concrete failure in compression.

b) Plot the variation of t/a versus the depth z for $z \geq 100$ m and for SF = 1 and 1.5. The input data are: σ_c=5,000 psi, E_c=3 x 10^6 psi, ν_c =0.2, E_r=1 x 10^6 psi (soft rock), ν_r=0.25, and γ=160 lb/ft^3.