Due Monday March 19, 2007

As seen in class, the vertical stress, σ, in square pillars of width W_p separated by a distance W_o and located at a depth, z, is equal to

$$\sigma = \gamma z \left(1 + \frac{W_o}{W_p}\right)^2 \tag{2}$$

The pillar stress must not exceed the pillar strength q. Let F be the safety factor against failure with F=q/σ. The strength q is defined using the Hoek and Brown failure criterion for rock mass strength, which under uniaxial condition reduces to

$$q = \sigma_c (s)^{1/2} \tag{3}$$

where σ_c is the unconfined compressive strength of the intact rock and s is a reduction factor that ranges between 1.0 (for intact rock) and 0.0000... (for very fractured rock).

a) Combining equations (2) and (3), show that

$$\frac{W_o}{W_p} = \sqrt{\frac{\sigma_c \sqrt{s}}{F \gamma z}} - 1 \tag{4}$$

The ratio W_o/W_p must always be positive. It is equal to zero (no mining possible) at a depth z_c equal to $(\sigma_c\sqrt{s})/(F\gamma)$.

b) The extraction ratio, R, is defined as the ratio between the mined area and the total area. Show that it is equal to

$$R = 1 - \frac{1}{\left(1 + \frac{W_o}{W_p}\right)^2} \tag{5}$$

c) As a numerical example, consider an iron ore with an intact compressive strength σ_c = 75 MPa, and a unit weight γ = 0.027 MPa/m. Show the variation of W_o/W_p and R with depth for depths less than 1000 m, for F = 1.0, 1.5 and 2.0 and for selected values of s =]0,1]. Conclude on the importance of rock mass fracturing on the mine design.