

Field exercise: Factor of Safety Calculation for slope stability

I derived this equation in the class notes for the Factor of Safety (FS) for the infinite slope case:

$$FS = \frac{c' + hg \cos^2 \theta (\rho_r - \rho_w m) \tan \phi}{\rho_r hg \sin \theta \cos \theta}$$

where

c' is the (effective) cohesion (as reduced by loss of surface tension)

h is the thickness of the potential slide

g is acceleration of gravity

θ is the dip angle of the potential failure plane

ρ_r is the density of rock in the potential slide

ρ_w is the water density

m is the portion of saturated thickness of the slide $m = 1$ for a fully saturated slide and $m = 0$ for a completely dry slide

ϕ is the angle of internal friction or $\tan \phi = \mu$ (plane friction)

$$FS > 1 \rightarrow \text{STABLE}; FS < 1 \rightarrow \text{UNSTABLE}; FS = 1 \rightarrow \text{CRITICAL}$$

Using that equation, answer the following. Show your work.

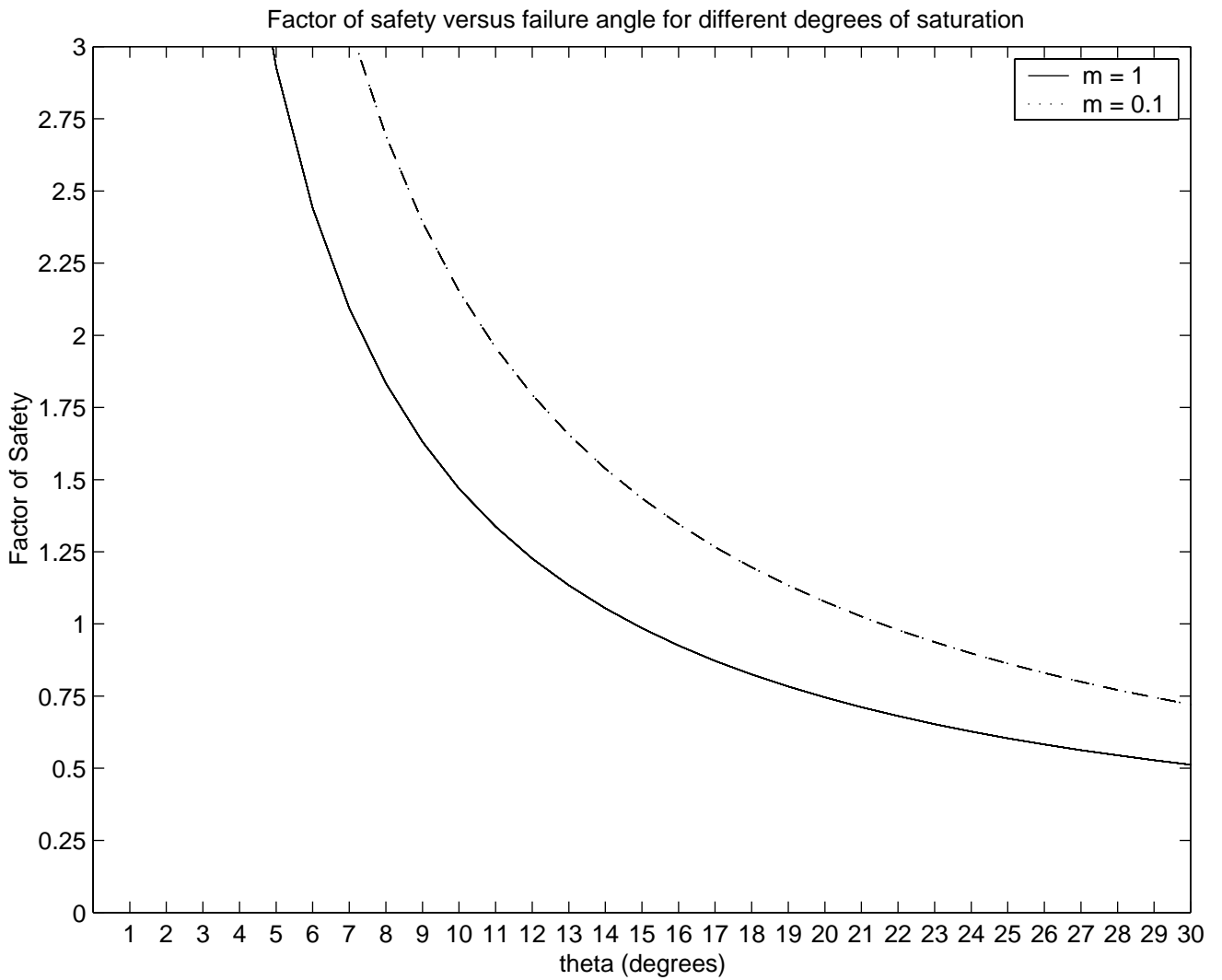
You are a landslide guru and a couple of different projects for estimating slope stability have been contracted to your company. You make the following observations:

Density of material in the slope: 2000 kg/m^3

Cohesion of material in the slope: $11900 \text{ kg s}^{-2} \text{ m}^{-2}$

Angle of internal friction: $\phi = 15^\circ$

1. If a 10 m thick slide mass is 50% saturated above a 17° potential failure surface, is it safe?
2. If the 10 m thick slide mass is unsaturated above a 17° potential failure surface, is it safe?
3. It is impractical to completely dry the above slide out ($m > 0$). What saturation is the maximum to have a safe slide?



The above figure shows a plot of FS versus theta for the general parameters (ρ_r , c' , and ϕ and slide thickness of 5 m) specified on the previous page given saturations of $m = 1$ and $m = 0.1$. Use this chart for the following 2 questions.

4. If this is in Oregon or Washington where the hill is completely saturated in the winter, what is the maximum stable slope ($FS = 1$) if the thickness of the potential slide mass is 5 m?

5. If the slide is in Arizona where the maximum saturation of the hill is only 10% of the slide thickness (again, $h = 5$ m), what is the maximum stable slope?