Slope stability analysis by Finite Elements

Advantages of the FE method over LEMs (Griffiths and Lane, 1999):

- No assumption needs to be made in advance about the shape or location of the failure surface. Failure occurs `naturally' through the zones within the soil mass in which the soil shear strength is unable to sustain the applied shear stresses.
- Since there is no concept of slices in the FE approach, there is no need for assumptions about slice side forces. The FE method preserves global equilibrium until `failure' is reached.
- If realistic soil compressibility data are available, the FE solutions will give information about deformations at working stress levels.
- The FE method is able to monitor progressive failure up to and including overall shear failure.
- Any constitutive behaviour could potentially be included in the analysis (e.g. partial saturation)

Slope stability analysis by Finite Elements

- F is defined – as in LEMs – as the number by which the original shear strength parameters must be divided in order to bring the slope to the point of failure (`shear strength reduction technique'):

$$c'_{\mathrm{f}} = c'/\mathrm{FOS}$$

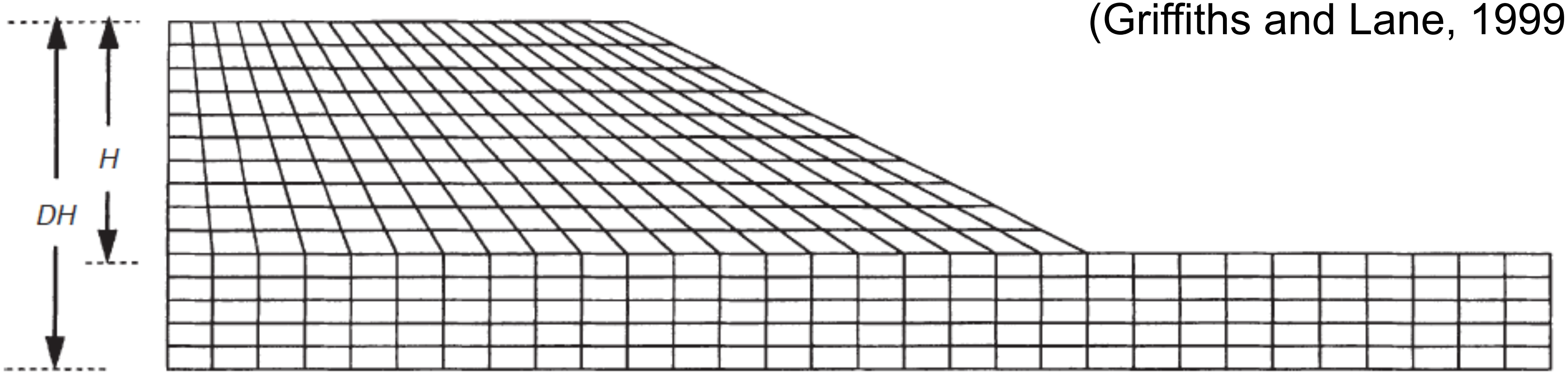
$$\phi'_{\mathrm{f}} = \arctan\left(\frac{\tan\phi'}{\mathrm{FOS}}\right)$$

- F is increased in (small) steps and a new equilibrated state with the reduced strength parameters is computed.

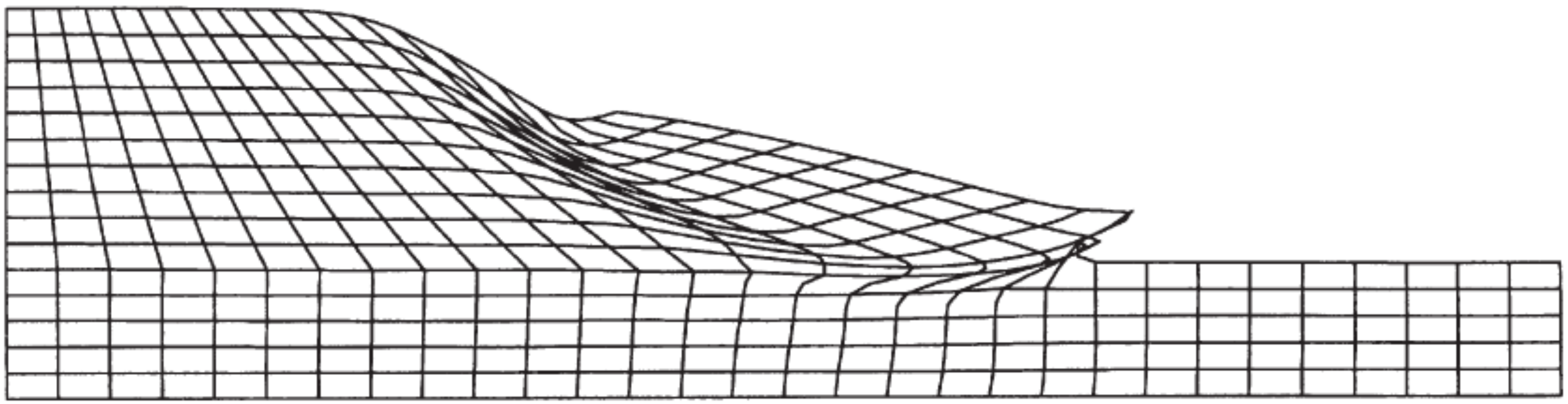
- Non-convergence of the solution (Zienkiewicz & Taylor, 1989) is often the assumed criterion to define the failure condition.
  - The user has to check that the computed failure mechanism is realistic.
  - Local non-convergence can provide false indications on F.

Slope stability analysis by Finite Elements

(Griffiths and Lane, 1999)



(a)



(b)

Fig. 5. Example 2: Homogeneous slope with a foundation layer. Slope angle 26·57° (2:1), $\phi' = 20°$, $c'/\gamma H = 0{\cdot}05$, $D = 1{\cdot}5$: (a) undeformed mesh; (b) mesh corresponding to unconverged solution with FOS = 1·4

Slope stability analysis by Finite Elements

(Griffiths and Lane, 1999)

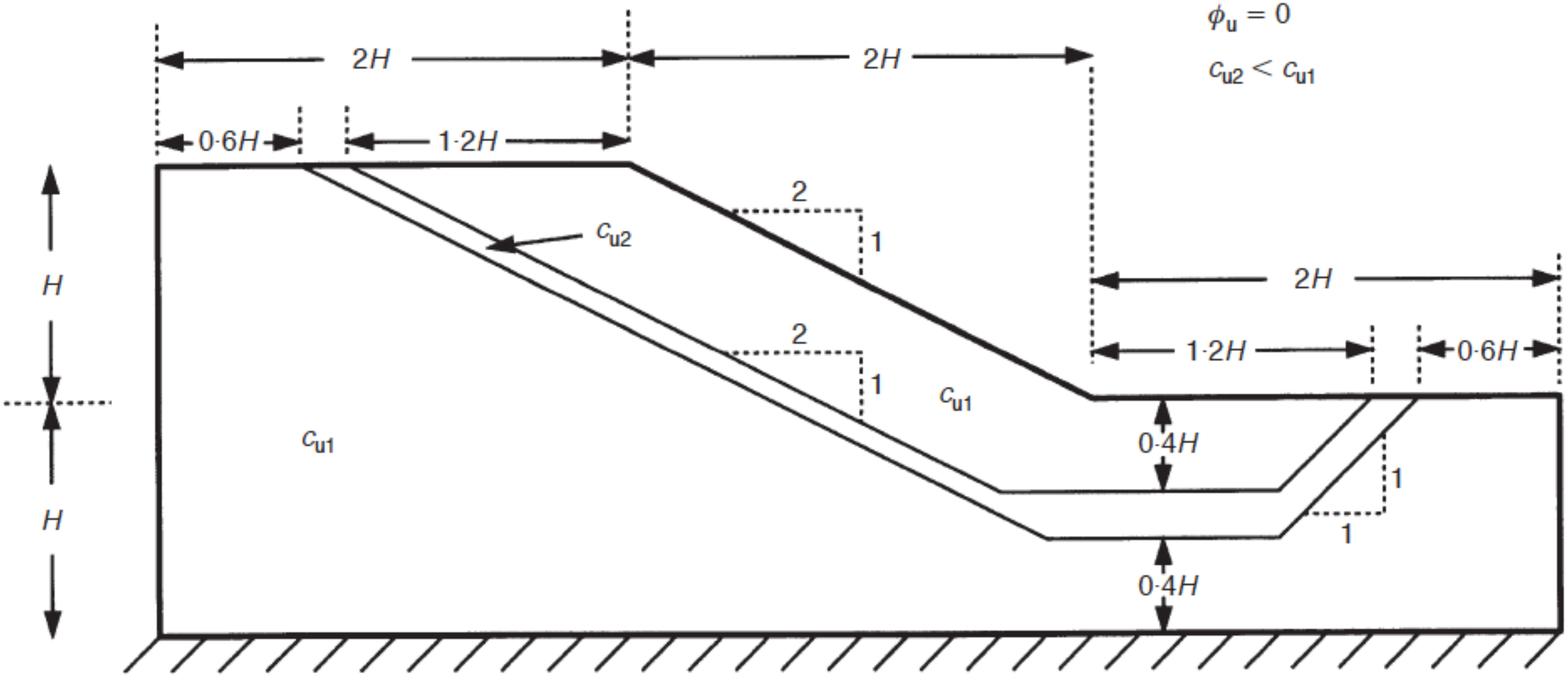


Fig. 6. Example 3: Undrained clay slope with a foundation layer including a thin weak layer ($D = 2$, $c_{u1}/\gamma H = 0{\cdot}25$)

Slope stability analysis by Finite Elements

(Griffiths and Lane, 1999)

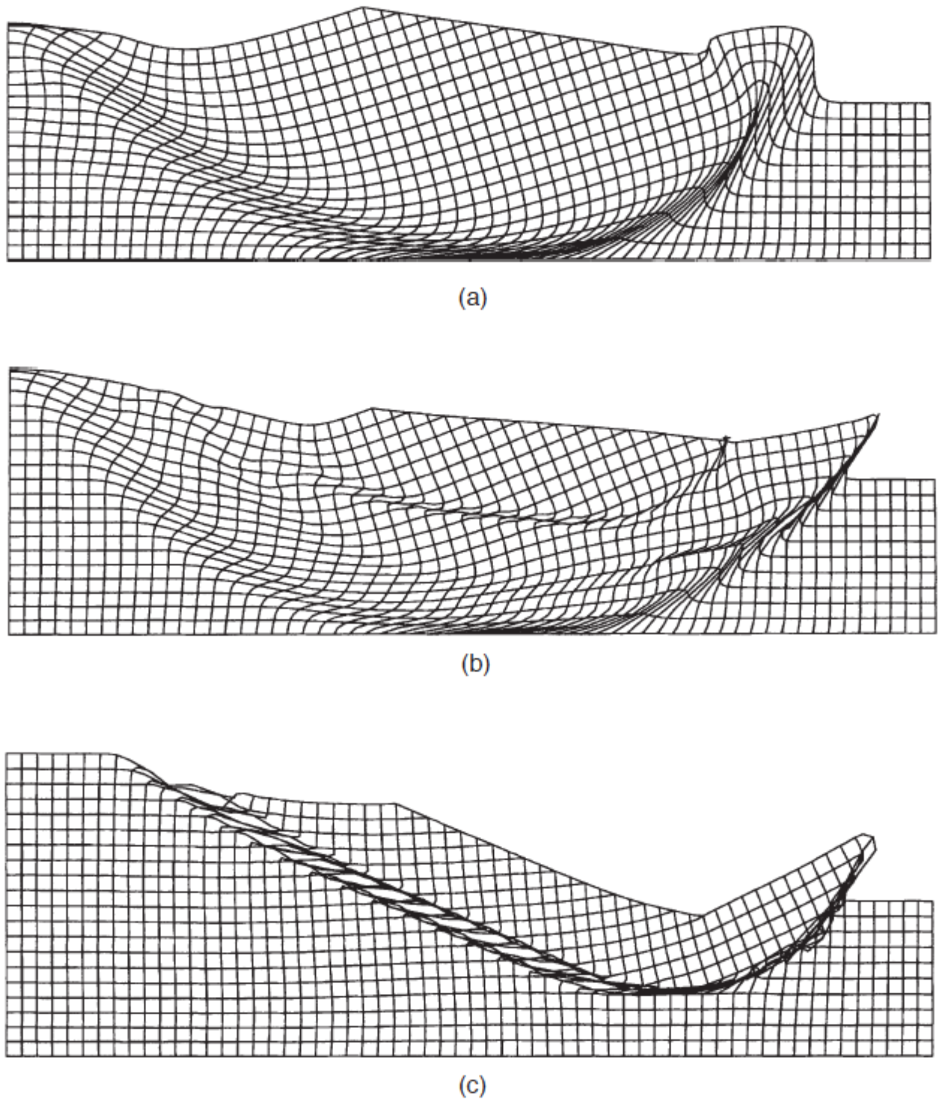


Fig. 8. Example 3: Deformed meshes at failure corresponding to the unconverged solution for three different values of c_{u2}/c_{u1} (a) $c_{u2}/c_{u1} = 1{\cdot}0$; (b) $c_{u2}/c_{u1} = 0{\cdot}6$; (c) $c_{u2}/c_{u1} = 0{\cdot}2$

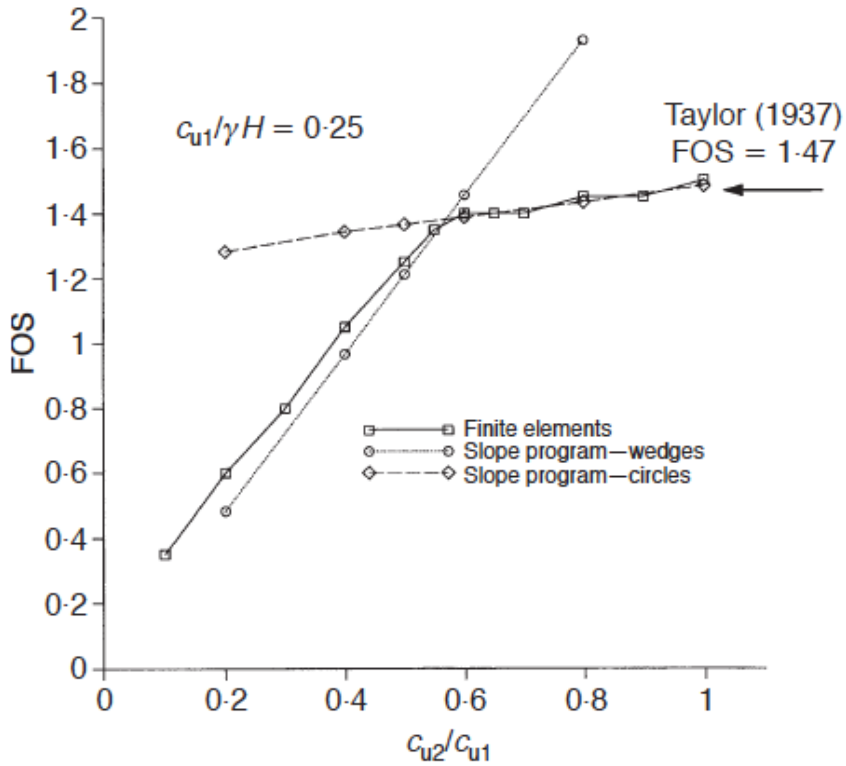


Fig. 7. Example 3: Computed factor of safety (FOS) for different values of c_{u2}/c_{u1}