

Article Stress-strain behavior of sand at high strain rates (Mehdi Omidvar et al,2012)

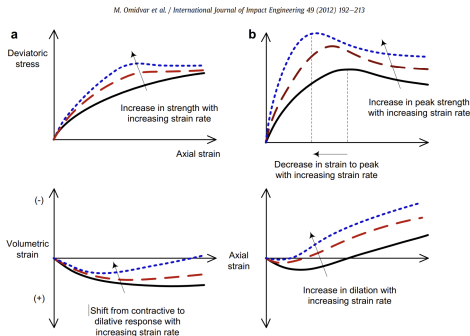


Fig. 19. Effect of increase in strain rate on stress-strain response and volumetric strains in (a) loose sand, (b) dense sand [interpreted based on data from Table 3].

"Under HSR loading, there is not enough time for strain energy accumulation, which prohibits crushing and promotes rolling-rearrangement resulting in a higher resistance to shear"

Trouver le régime de l'état critique

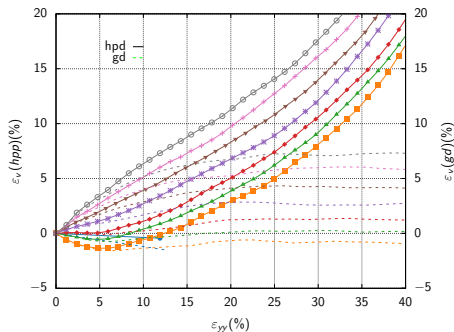


Figure 1 – Déformation Volumique

$$\begin{aligned} \text{hpd} : \varepsilon_{yy} &= \frac{\Delta h_{yy}}{h_{yy}^0}; \varepsilon_v = \varepsilon_{xx} + \varepsilon_{yy} + \varepsilon_{zz} \\ \text{gd} : \varepsilon_{yy} &= \ln \left(\frac{h_{yy}}{h_{yy}^0} \right); \varepsilon_v = \frac{\Delta V}{V_0}; \end{aligned}$$

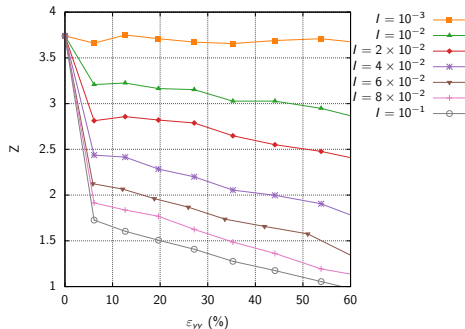


Figure 2 – Nombre de Coordination

$$Z = \frac{2N_{\text{contact}}}{N_{\text{particule}}}; I = \frac{v}{H_0} \sqrt{\frac{m}{Pa}}$$

Trouver le régime de l'état critique

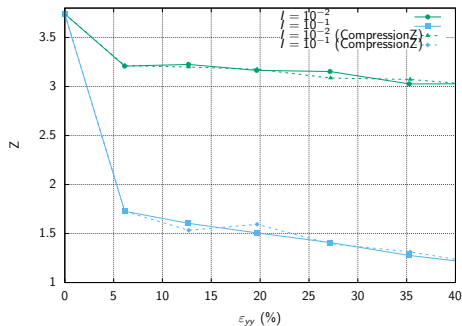


Figure 3 – Nombre de Coordination

échantillon aléatoire par compression
dans l'axe Z

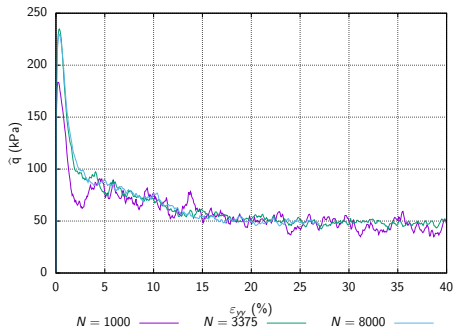


Figure 4 – Nombre de Particules

État Rankine - Modèle

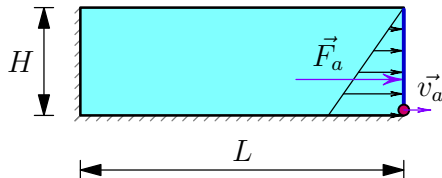


Figure 5 – Pression active : le mur s'éloigne du sol

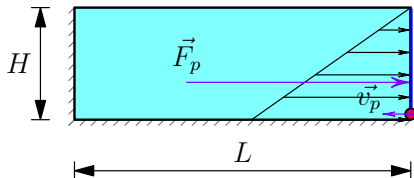


Figure 6 – Pression passive : le mur se rapproche du sol

Observer la pression sur le mur en bleu

Paramètres principaux

| Symbole | Paramètre | Valeur |
|-----------|---|------------------------|
| L | Longueur | 3 m |
| H | Hauteur | 1 m |
| ρ | Densité | 2700 kg/m ³ |
| E | Module de Young | 1×10^9 Pa |
| ν | Coefficient de Poisson | 0.2 |
| φ | Angle de frottement interne | 25° |
| ψ | Angle de dilatance | $\approx 0^\circ$ |
| v | Vélocité de déplacement | 0.005 m/s |
| c | Cohésion | 0 & 100 Pa |
| μ | Coefficient de frottement entre le mur et les PMs | 0 |

Table 1 – Paramètres du modèle (loi Mohr-Coulomb)

État Rankine - Stabiliser

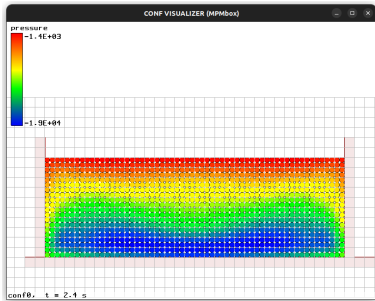


Figure 7 – Pression en bas

$$P_{\text{théorique}} = 2.65\text{e}4 \text{ (Pa)}$$

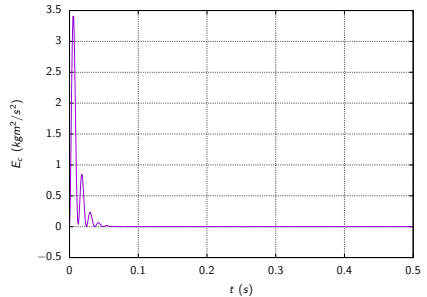


Figure 8 – Énergie cinétique

$$P_{\text{simulation}} = 2\text{e}4 \text{ (Pa)}$$

→ L'écart est 0.65 kPa

État Rankine - Théorie

Coefficient K : la relation entre la contrainte verticale et horizontale :

- Poussée active : $K_a = \frac{1 - \sin(\varphi)}{1 + \sin(\varphi)} = 0.406$
- Poussée passive : $K_p = 1/K_a = 2.464$
- État au repos : $K_0 = 1 - \sin(\varphi) = 0.577$

La somme de pression F (kN) appliqué sur le mur :

Sans cohésif :

$$F_a = \frac{1}{2} \gamma H^2 K_a = 5.376861$$

$$F_p = \frac{1}{2} \gamma H^2 K_p = 32.619458$$

$$F_0 = \frac{1}{2} \gamma H^2 K_0 = 7.647$$

Cohésif :

$$F_a = \frac{1}{2} \gamma H^2 K_a - 2cH \sqrt{K_a} = 5.249425$$

$$F_p = \frac{1}{2} \gamma H^2 K_p + 2cH \sqrt{K_p} = 32.93334$$

$$F_0 = \frac{1}{2} \gamma H^2 K_p + 2cH \sqrt{K_0} = 7.495$$

État Rankine reposé

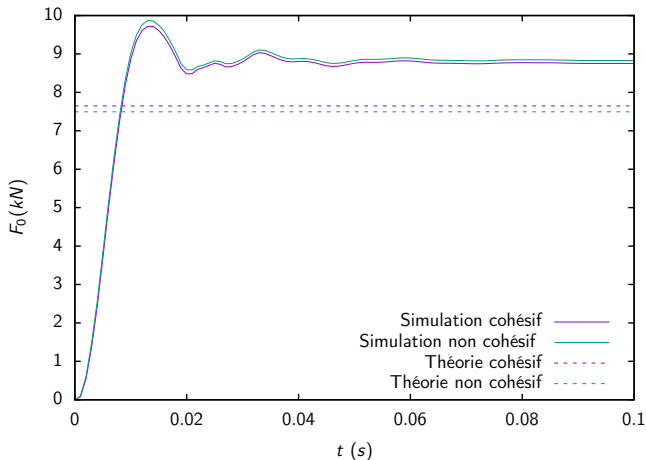


Figure 9 – Pression sur le mur en bleu

→ L'écart est 1 kPa (13%)

État Rankine - film de mur bougé

Figure 10 – Pression active

Figure 11 – Pression passive

État Rankine - Pression Active

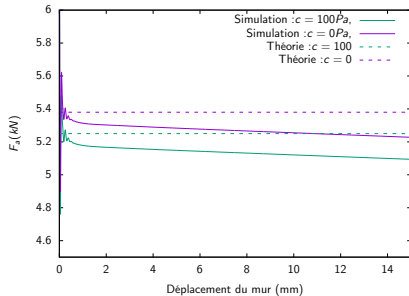


Figure 12 – Pression active
 $v = 0.005 = \text{const}$

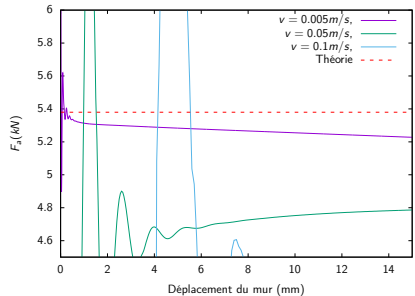


Figure 13 – Pression active
 $c = 0 = \text{const}$

Effet cinétique ? Résistance rigide du matériau ?

→ L'écart est 0.2 kN (3%)

État Rankine - Pression Passive

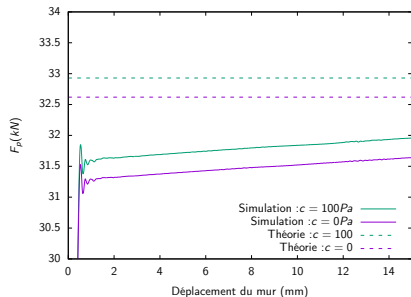


Figure 14 – Pression passive
 $v = -0.005 = \text{const}$

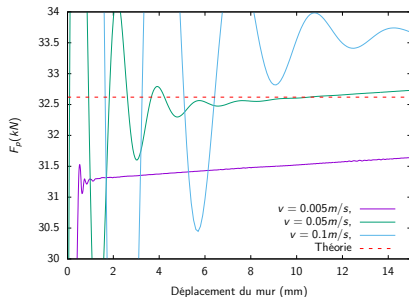


Figure 15 – Pression passive
 $c = 0 = \text{const}$

Effet cinétique ?

→ L'écart est 1 kN (3%)