

TULIP – INFLUENCE DE LA LOI DE COMPORTEMENT

14 octobre 2021

LOI DE COMPORTEMENT ANL

Problématique : Réduire la largeur de la cuvette de tassement estimée par MEF

- Analyse des spécificités de l'excavation du tunnel
 - Chargement principalement déviatorique
 - Déformations avant rupture confinement
 - Dépendance forte au module de cisaillement transverse
- Proposer des mécanismes simples et indépendants

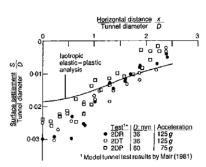


Fig. 11. Observed and predicted settlement troughs assuming isotropy; C/D = 1.67; $\sigma_T = 92 \text{ kPa}$

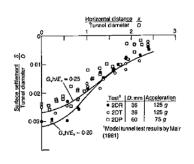
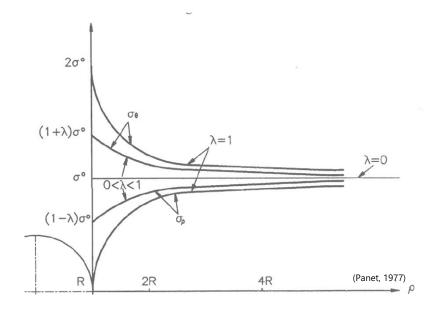


Fig. 13. Effect of anisotropic ratio $G_{\rm vh}/E_{\rm v}$ on surface settlement trough

(Lee, 1989)



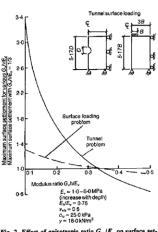


Fig. 2. Effect of anisotropic ratio G_{ub}/E_u on surface settlement ratio R_u for surface loading and tunnelling problem

(Lee, 1989)



LOI DE COMPORTEMENT ANL

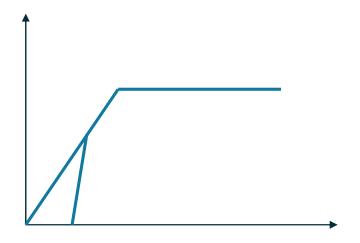
Réduire la largeur de la cuvette de tassement

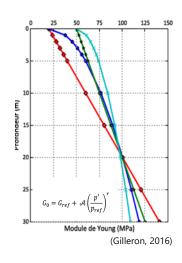
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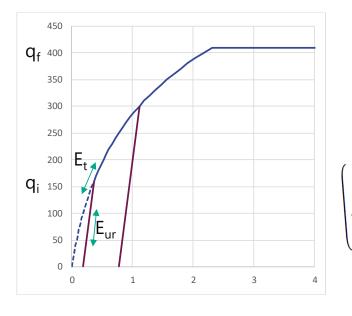
Mécanismes intégrés – CESAR NELAS24

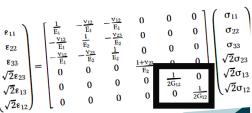
- Élasticité linéaire avec rupture de Mohr-Coulomb
- Déchargement/rechargement ⇔ E_{ur}
- Dépendance de la raideur à la contrainte moyenne ⇔ coefficient *m* (HSM)
- Élasticité non linéaire sous chargement déviatorique ⇔ écrouissage déviatorique
- Isotropie transverse (spécificité tunnel superficiel)
- Pas de critère isotrope / cap (spécificité du tunnel)





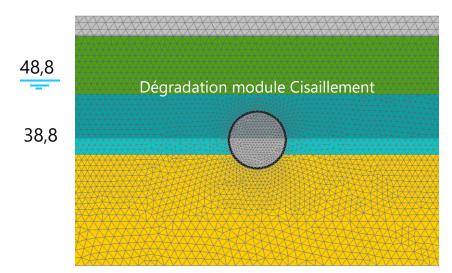


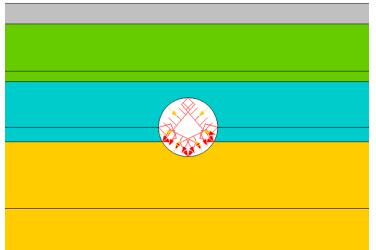


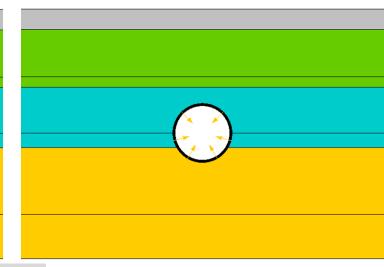


MODÉLISATION DU CREUSEMENT

Modèle 2D avec CESAR-LCPC







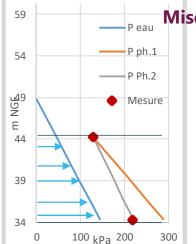
Initialisation des contraintes effectives

Déconfinement 90 % Pression explicite

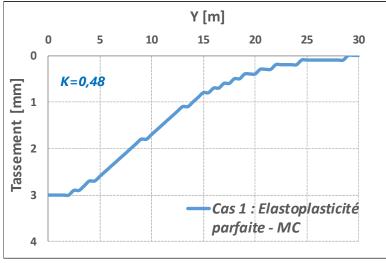
TABLEAU 1. DONNÉES GÉOTECHNIQUES TUNNEL

Formation	Côte NGF toit	γ _h [kN m ⁻³]	E _{M-h} [MPa]	ν	c' [kPa]	φ' [°]	ψ' [°]
Remblais (RB)	60,3	19	18	0,30	0	28	0
Calcaires Saint-Ouen (SO)	56,8	18	34	0,30	20	33	0
Sables de Beauchamp (SB)	47	21	75	0,37	10	33	3
Marnes et Caillasses (MC)	36,8	20	187	0,30	50	35	0



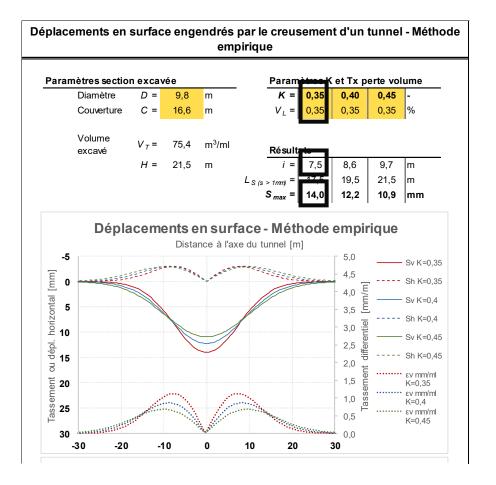


Mise en place de l'anneau de voussoirs

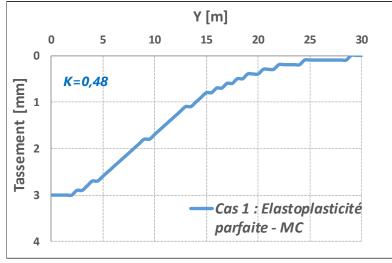


u _{zmax}	Y _{60%}		
[mm]	[m]		
3,0	10,0		
3,0	10,0		

$$E_t = \frac{\lambda E_{M-h}}{\alpha}$$
 $\lambda = 2, \alpha = 0,5$

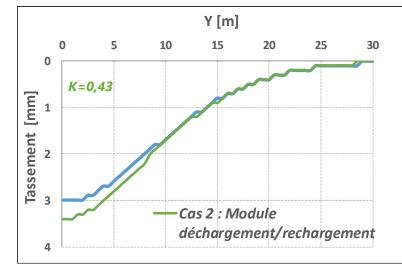




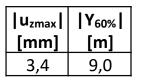


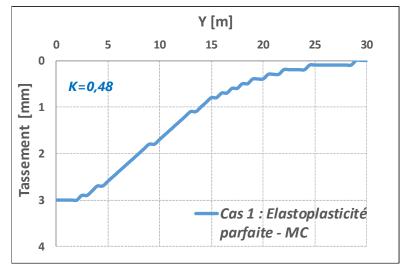
E.	$=\frac{\lambda E_{M-h}}{\alpha}$	$\lambda = 2, \alpha = 0.5$
-ι	α	70 = 0,00

u _{zmax} [mm]	Y _{60%} [m]	
3,0	10,0	

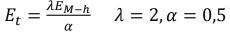


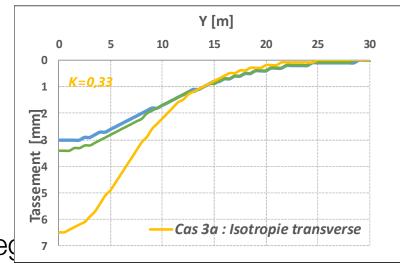
$$E_{ur} = 3.E_t$$



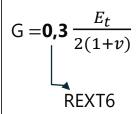


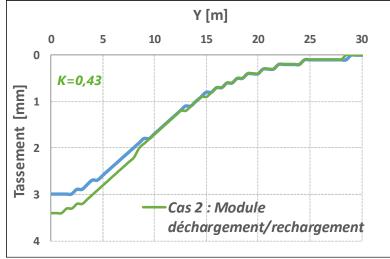
u _{zmax}	Y _{60%}
[mm]	[m]
3,0	10,0

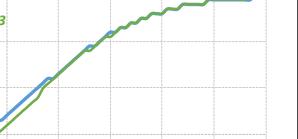




u _{zmax}	Y _{60%}
[mm]	[m]
6,5	7,0







|Y_{60%}|

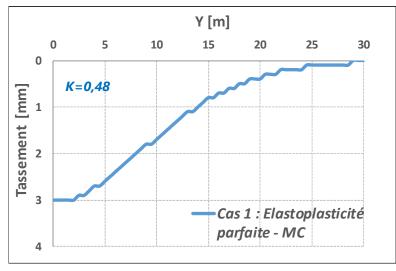
[m]

9,0

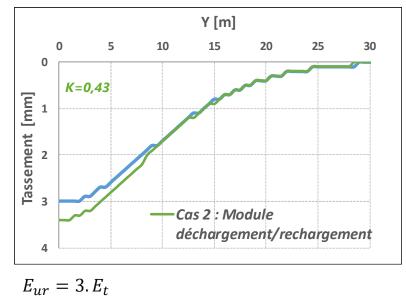
|u_{zmax}|

[mm]

3,4

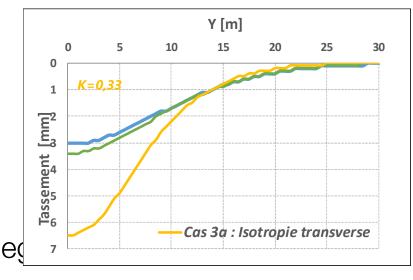


u _{zmax}	Y _{60%}		
[mm]	[m]		
3,0	10,0		



u _{zmax}	_
3,4	9,0

$$E_t = \frac{\lambda E_{M-h}}{\alpha}$$
 $\lambda = 2, \alpha = 0.5$



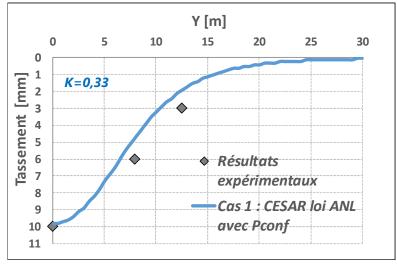
u _{zmax}	Y _{60%}		
[mm]	[m]		
6,5	7,0		

G =**0,3**
$$\frac{E_t}{2(1+v)}$$

5	10	15	20	25	-
			_0	25	30
0,33					
	/				
/					
		as 4 : El	asticité l	non liné	aire
			—Cas 4 : El	—Cas 4 : Elasticité i	—Cas 4 : Elasticité non liné

u _{zmax} [mm]	Y _{60%} [m]	
7,3	7,0	
	Raideur confine surestin	ment

PHASE 2 – CLASSE C

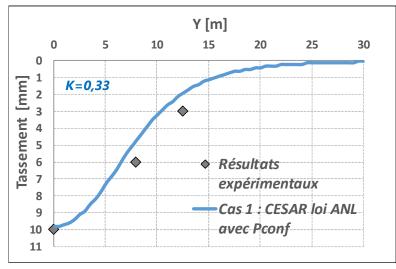


u _{zmax}	Y _{60%}
[mm]	[m]
9,8	7,0

Recalage pression de confinement (u_z+2,5 mm)

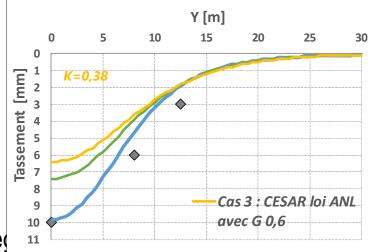


PHASE 2 – CLASSE C

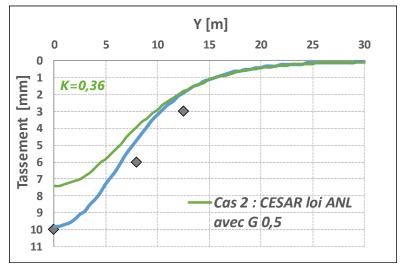


u _{zmax}	Y _{60%}
[mm]	[m]
9,8	7,0

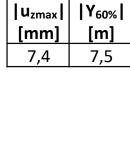
Recalage pression de confinement (u_z+2,5 mm)



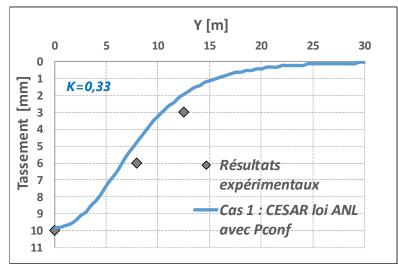
u _{zmax}	Y _{60%}
[mm]	[m]
6,4	8,0



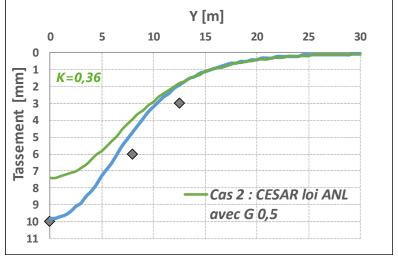
Itération 1 Module de cisaillement transverse



PHASE 2 – CLASSE C

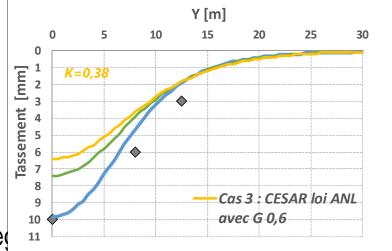


u _{zmax}	Y _{60%}
[mm]	[m]
9,8	7,0



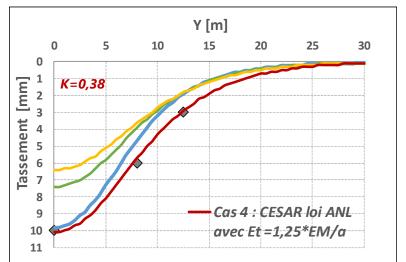
|Y_{60%}| **u**zmax [mm][m] 7,5 7,4

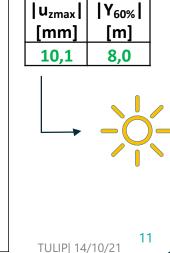
Recalage pression de confinement (u_z+2,5 mm)



Itération 2 Module de cisaillement transverse

Itération 1 Module de cisaillement transverse





Recalage module de raideur

|Y_{60%}|

[m]

8,0

|u_{zmax}|

[mm]

6,4

SYNTHÈSE

Bonne compétence de la loi de comportement à reproduire les tassements en surface, en amplitude et en largeur.

Coefficient de dégradation du module de cisaillement à confirmer sur d'autres rétro-analyses. À associer avec des modélisations plus complexe du creusement.

Opportunité de développement d'une méthodologie pour l'étude d'interaction pieu/tunnel.



