4th International Conference on Rehabilitation and Maintenance in Civil Engineering (ICRMCE)

Contribution of Suction in the Stability of Reinforced Retaining Walls

Presented by

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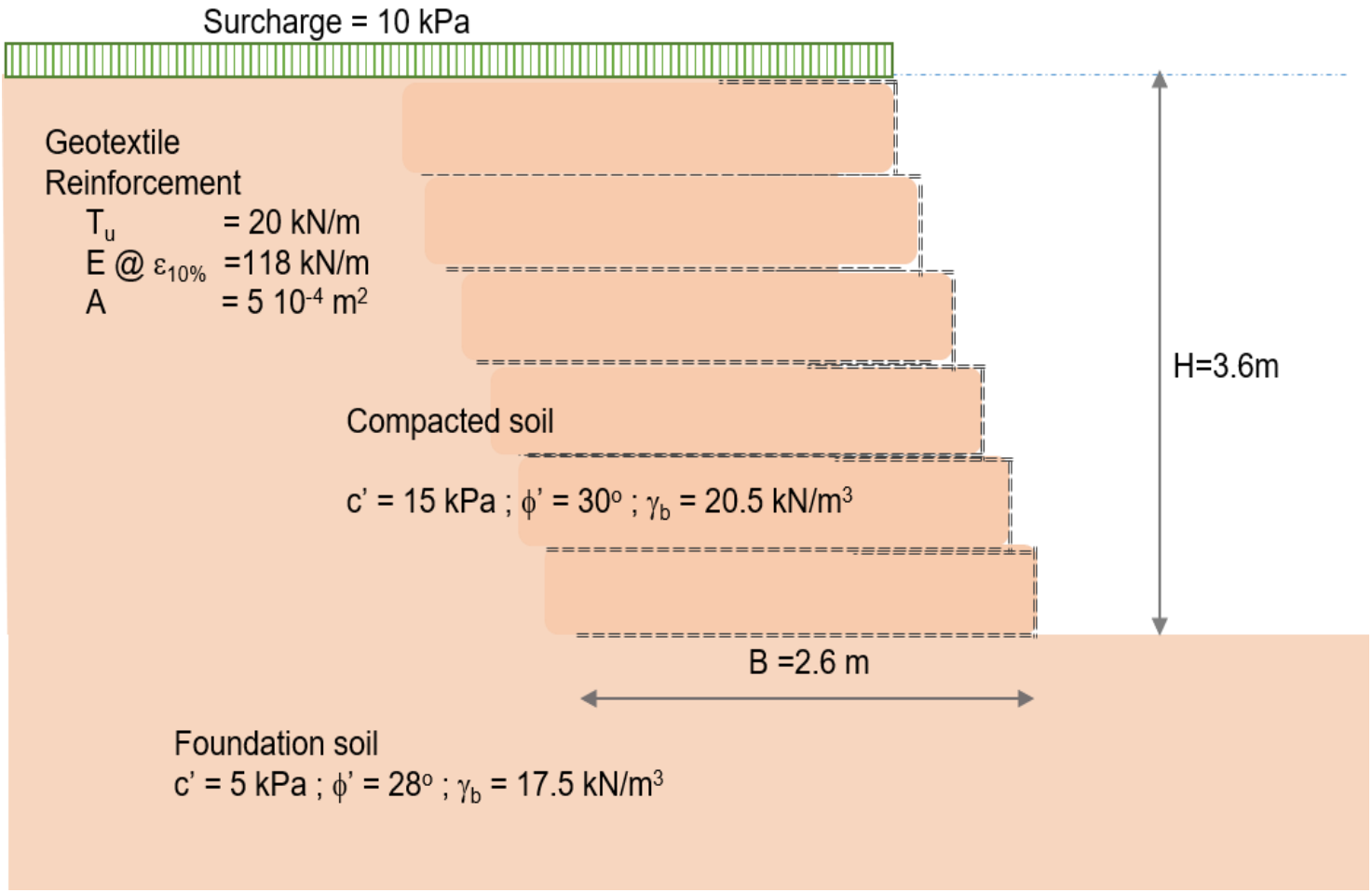
Objectives

To evaluate the contribution of cohesion (derived from soil's mineralogy and suction) on the stress transferred to the reinforcing element using three different methods (A, B and C) .

Scope of works

Analyses were carried out on a typical reinforced soil retaining wall (3.6 m high, sloping at 70^{o} to horizontal, and reinforced by six geotextile layers). The reinforced backfill was cohesive soil with total cohesion of 15 kPa. A parametric study was performed for a range of suctions from 10 to 50 kPa with intervals of 10 kPa.

Case studied



Ref: Gofar, 1994

Components of Reinforced soil wall for case study

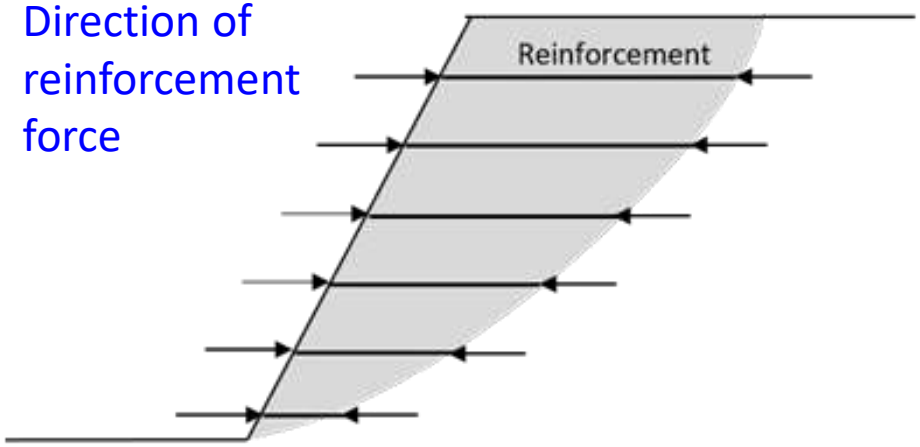
Components	Material	Properties
Backfill soil	Compacted in-situ soil	$c' = 15$ kPa ; $\phi' = 30^o$; $\gamma = 20.5$ kN/m^3
Reinforcement	Geotextiles	$T_u = 20$ kN/m; E at ε=10% = 118 kN/m; A = 5×10^{-4} m2
Facing Element	Geotextiles	Wrap around face
Foundation soil	Cohesive	$c' = 5$ kPa ; $\phi' = 28^o$; $\gamma = 17.5$ kN/m^3

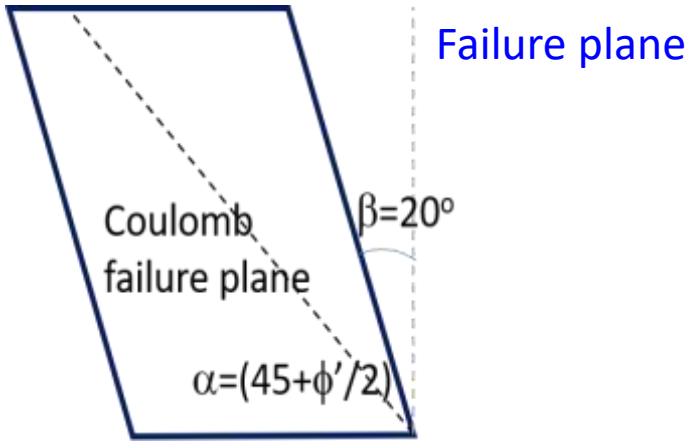
Methods considered in the study

Method	Reference	Methodology
A	Wright and Duncan (1991) Koerner (2005)	Stability analysis of Reinforced slope using SLOPE/W (Geoslope Intl, 2012)
B	AASHTO (2009), FHWA (2009)	Consider suction by adopting Rankine's/Coulomb's lateral pressure distribution on retaining walls
C	Allen & Bathurst (2015)	Simplified stiffness method (using Empirical equation for effect of suction)

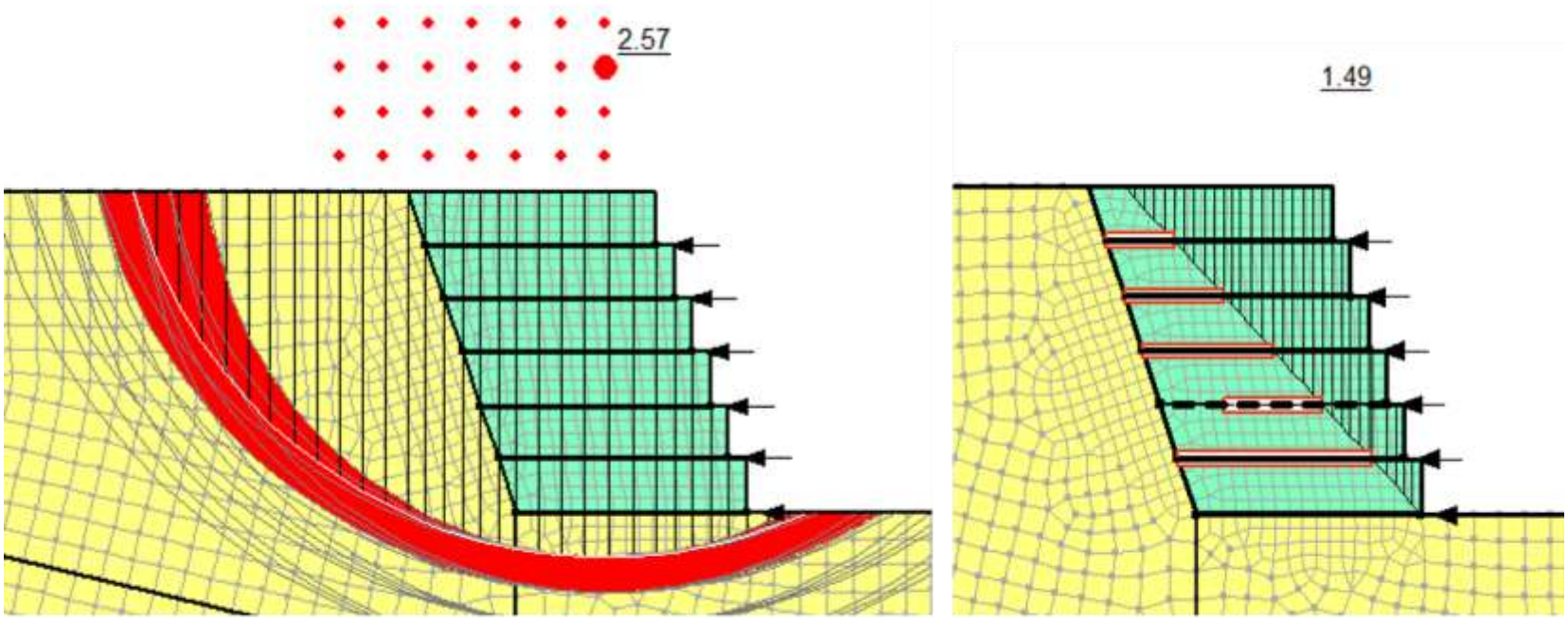
Assumptions involved

Direction of reinforcement force





Results: Baseline case ; c = 0
External stability



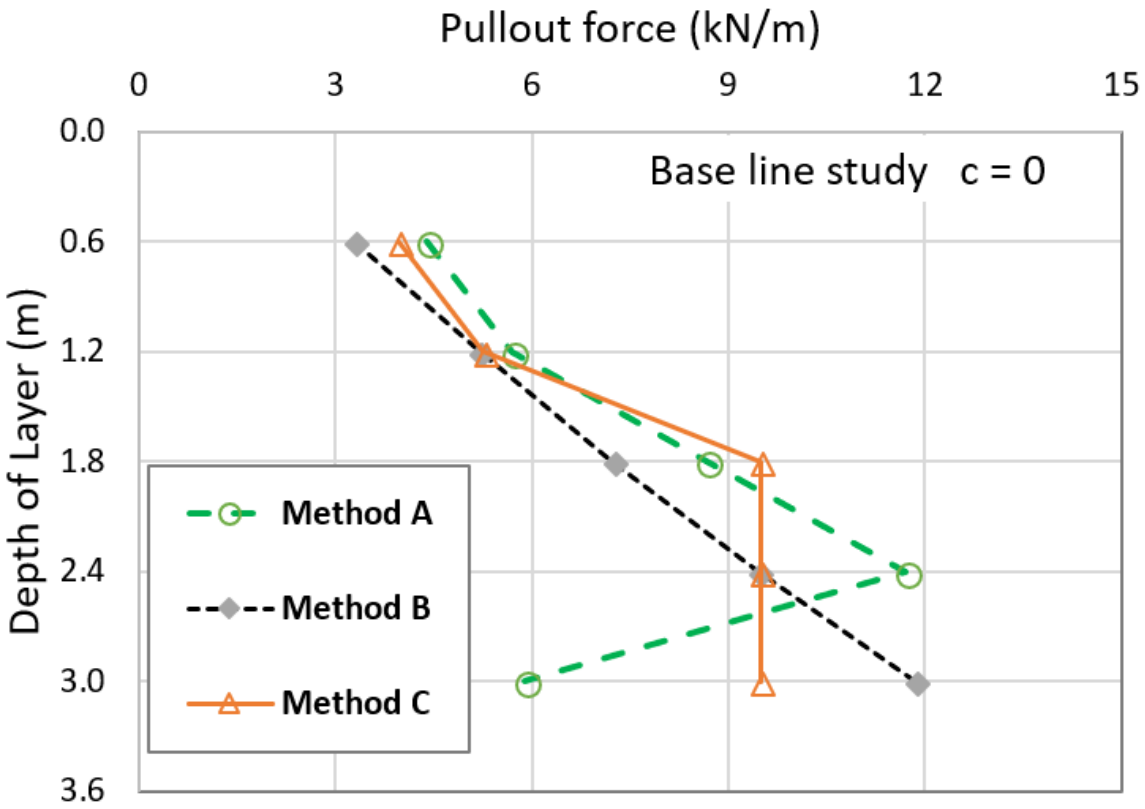
(a) Overall stability (b) Local stability

FoS sliding = 2.20;

FoS overturning = 9.72;

FoS bearing capacity = 7.16

Results: Baseline case ; c = 0 Tensile / Pull- force in each reinforcing element calculated using Methods A, B, and C

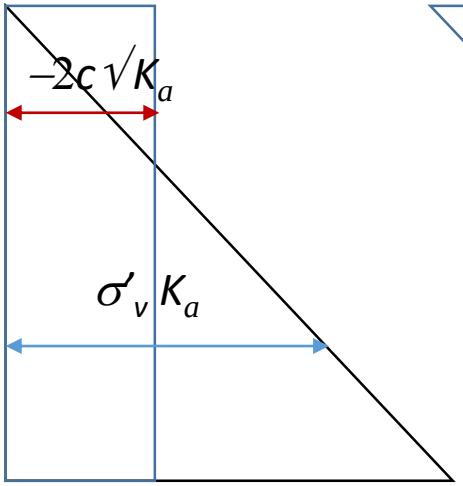


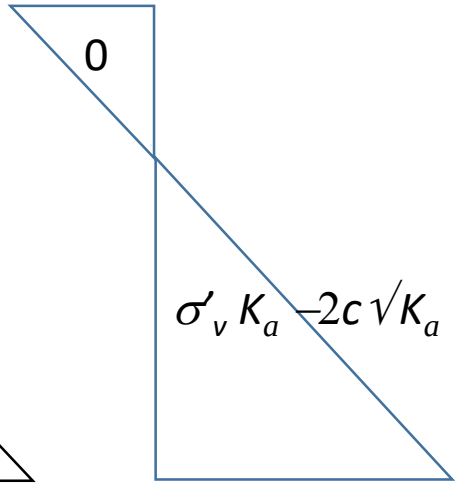
Suction values and total cohesion

Suction (ψ) kPa	Total cohesion $c = c' + \psi \tan\phi^b$ (kPa)
0	0
0	15
10	18.6
20	22.3
30	25.8
40	29.6
50	33.2

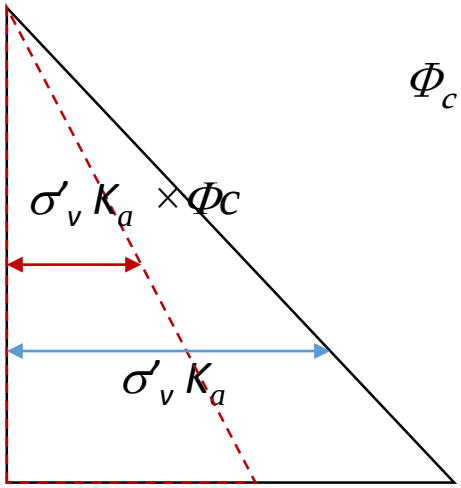
Effect of suction

Method B





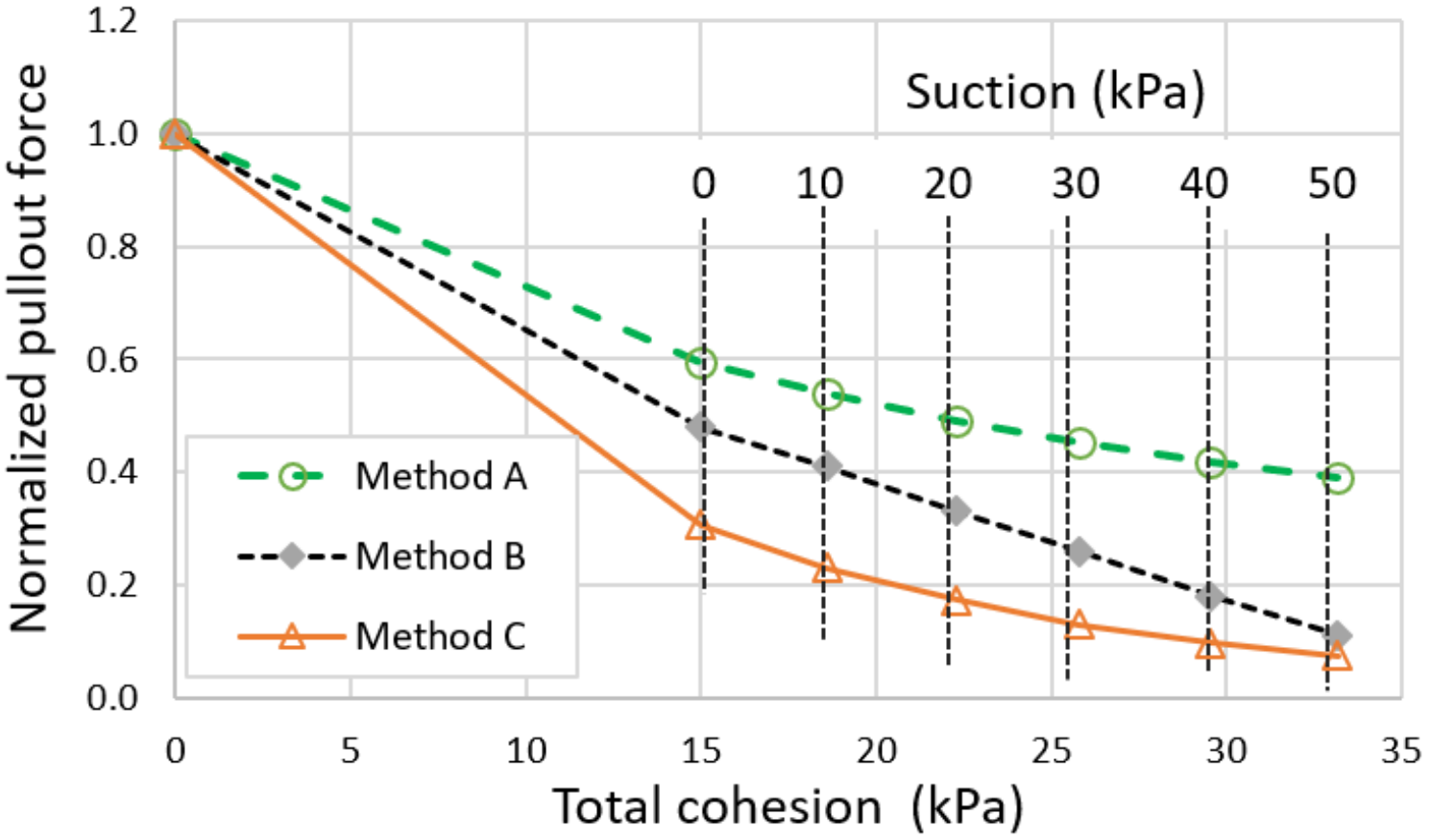
Method C



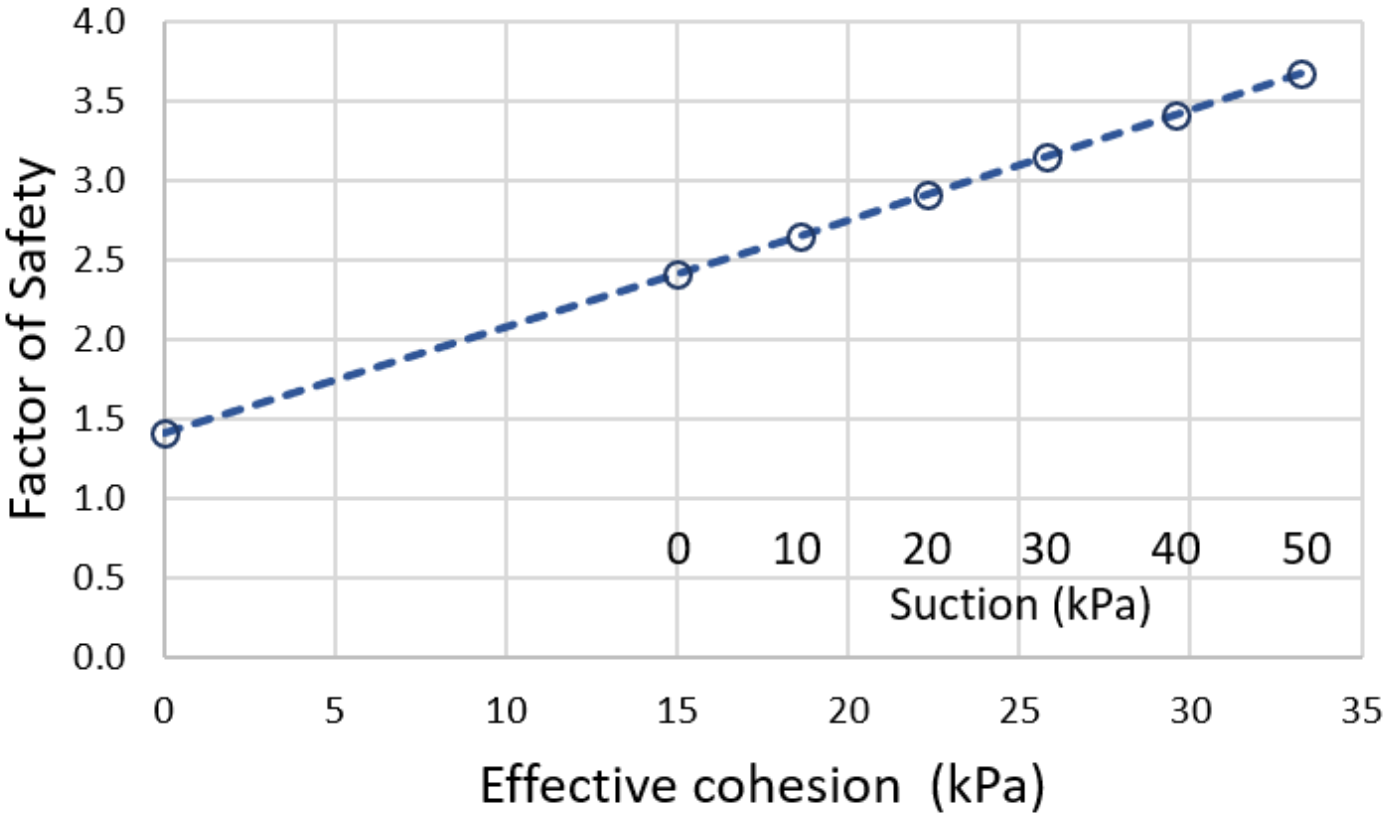
$$\Phi_c = e^{\lambda c/\gamma H}$$

where $0 \geq \Phi_c \geq 1$

Effect of suction on the Normalized Tensile / Pull- force in each reinforcing element calculated using Methods A, B, and C



Effect of suction on the internal stability of reinforced soil retaining wall



Conclusions

1. The presence of suction decreases the maximum force resisted by the reinforcing element. However, **methods A, B, and C showed different degrees of influence of suction on the stress transferred to the reinforcing element**.
2. The contribution of cohesion on the current design guidelines by adopting Rankine's horizontal pressure distribution in the retaining wall for active condition provides a more reasonable effect as compared to the simplified stiffness method. **Therefore, the contribution of suction as part of cohesion existing in the cohesive backfill could be considered for the stability analysis of reinforced soil retaining walls using the available design guidelines.**
3. There is an increase in the local stability of the reinforced soil retaining wall due to suction. **However, in order to preserve the contribution of the suction in the stability of the wall, the compacted backfill soil should be maintained by protecting the wall from rainfall infiltration, rise of the ground water table and seepage from the back of the reinforced zone.**

Thank you

Terimakasih