Implication on kick-out capacity analysis based on different assumptions

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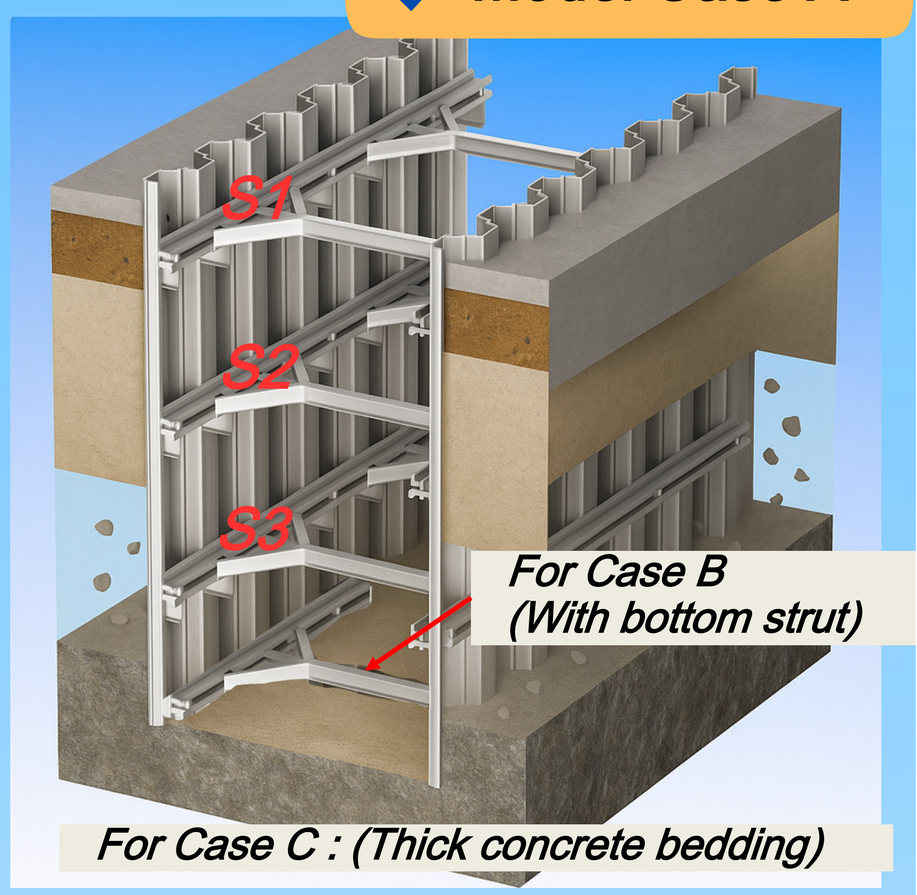
Introduction

- *Deep excavations are commonly required in Hong Kong for works such as pipe jacking and basement construction . ELS systems are widely used to support the ground, but the design of struts —especially the bottom strut —can affect safety and wall movement . This study compares ELS systems with and without a bottom strut to improve design reliability .*

Objectives

- *Study the moment behaviour of multi -strutting Excavation and Lateral Support (ELS) systems under different conditions and compare the structural response with and without an additional bottom strut at the last level .*



Summary Results

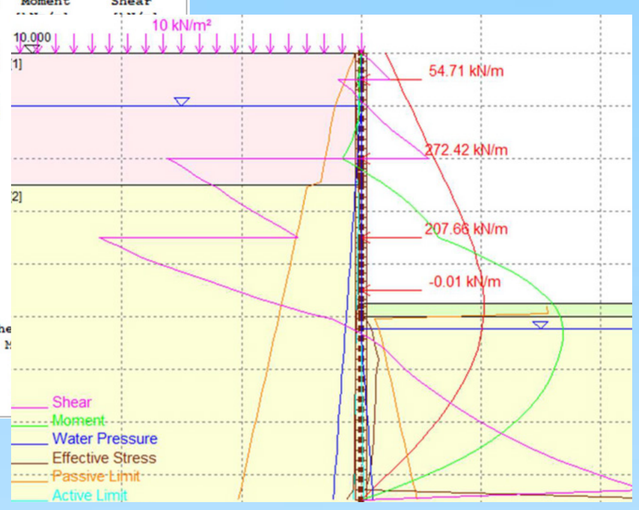
	Node	Level [m]	Displacement [mm]	Moment	Shear
Top wall node	1	10.00	40		
Above strut 4	30	1.00	24		
Below strut 4					
Max Shear	31	0.63	23		
Wall toe	52	-7.00	0.0		

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	4				209.69
2	13				337.18
3	23				217.04
4	30	-171.54	-171.54	0.00	171.54

Results Envelope

Node	Level [m]	Displacements [mm] Min	Max	Moments [kNm/m] Min	Max	She
1	10.00	5.10	43.96	0.00	0.00	
2	9.67	5.99	43.26	-1.92	0.00	
3	9.33	6.69	42.56	-7.99	0.00	
4	9.00	6.53	41.87	-17.75	0.00	

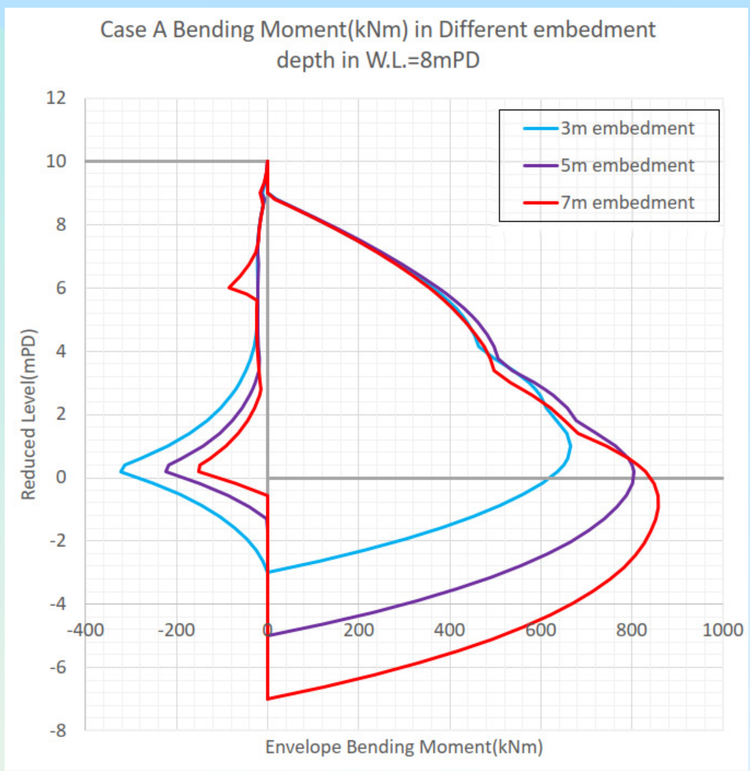


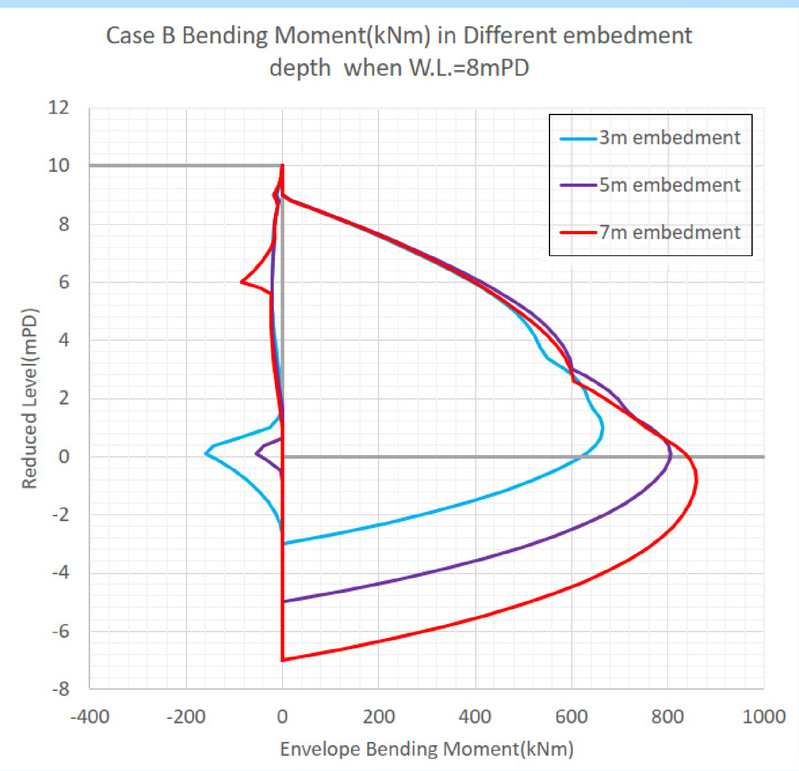
Methodology

- *This study used both Excel and Oasys Frew for analysis . Excel was applied to calculate initial values like bending moments and lateral forces . Frew simulations were then used to model soil - structure interaction across various excavation stages, comparing cases with and without a bottom strut . Inputs included soil type, strut size, and surcharge loads . Outputs such as displacement and moment diagrams were used to assess kick -out capacity .*

Findings

1. *Case A (no bottom strut): Higher stress and deflection; weakest under deep excavation and high -water table.*
2. *Case B (with bottom strut): Best performance overall; higher moment but better control of displacement and force.*
3. *Case C (concrete bedding): Balanced performance; less bending resistance than Case B but good deflection control.*
4. *Deeper embedment improves stability but increases bending moment and deflection.*
5. *High water level causes more lateral pressure. Case B and C handle it better than Case A.*
6. *Case A is only suitable for shallow excavation with low water pressure.*





Difference between A, B and C in W.L.=8mPD, ED=5m

W.L. : 5mPD	A	B	Difference to B	C	Difference to C
Moment at S1 level (kNm/m)	-7.94	-8.08	2%	-7.89	-1%
Moment at S2 level (kNm/m)	213.48	250.52	17%	193.11	-10%
Moment at S3 level (kNm/m)	379.07	393.2	4%	363.26	-4%
Moment at S4 level (kNm/m)	-	482.17	-	-	-
Design Moment on Wall(kNm/m)	484.49	484.69	0.0%	487.16	0.6%
Design Shear on Wall(kN/m)	247.1	249.7	1.1%	285.75	16%
Maximum Deflection(mm)	15.88	23.4	47.4%	10.29	-35%

Conclusion

1. *Adding a bottom strut greatly improves ELS system safety in deep excavations.*
2. *It helps reduce deflection and better distribute bending moments.*
3. *Concrete bedding is a good alternative for moderate -depth excavations with easier construction.*
4. *Case A is not recommended for deep cuts or high -water tables.*
5. *Proper design of strut levels and embedment depth is important for safe and cost -effective excavation.*