Oasys Frew Webinar - Session 2 of 2 Embedded Retaining Wall Analysis

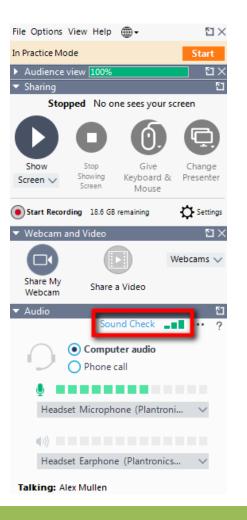


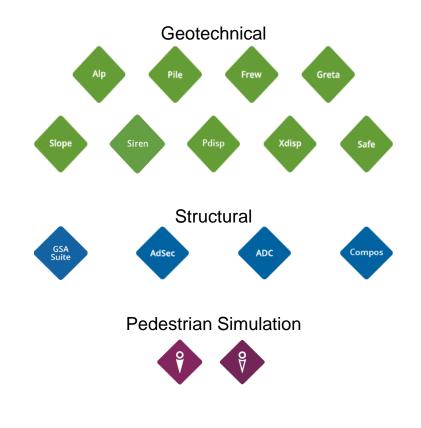


The webinar has started

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Can you hear us?







Who is Oasys?



- Wholly owned by Arup
- Formed in 1976 to develop software for in-house and external use
- Most programming and sales staff are engineers
- In recent years have added marketing and sales staff
- Have expanded the development team worldwide









Frew Training Webinar Session 2 Objectives

- Cover Advanced Analysis Methods
 - General Modelling Methods
 - Integral Bridge Analysis
 - Seismic Analysis

Previous Webinars:

- Partial Factors (EC7)
- Automation/sensitivity analysis

Session 1 – Introduction to Methodology and setting up a model



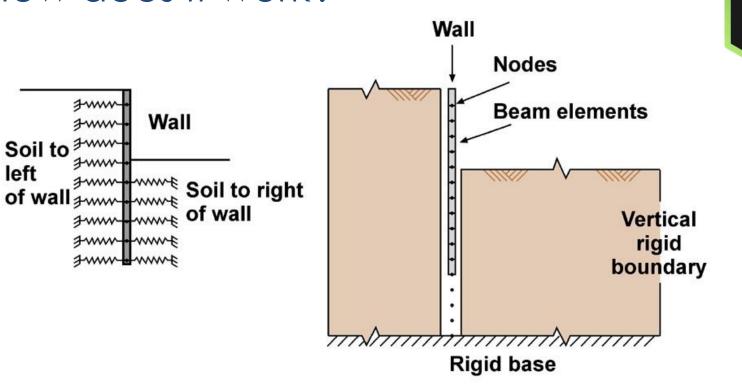
What does it do?



- Embedded retaining wall analysis over the complete construction sequence
- Soil structure interaction/pseudo FE so calculates soil response using FE mesh results
- Stability checks for cantilever and propped walls
- Earth and water pressure calculations at every stage
- Suitable for sheet pile, secant, contiguous or diaphragm walls



How does it work?



Subgrade reaction model

FREW

- Wall modelled as series of elastic beam elements
- Soil to each side of the wall connected to nodes
- Only horizontal forces are transmitted

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Methods of Analysis

- Limit Equilibrium
 - Checks stability of wall for assumed failure mechanism
- Soil-Structure Interaction (SSI)





Modelling methods

- Effects to be modelled:
 - Undrained-drained transition
 - Modelling props
 - Relaxation & Creep
 - Modelling Sloping Ground
 - Modelling Berms
 - Modelling Shafts
 - Thermal Effects





Undrained-drained transition

- Sequence
 - Initialise stresses with drained materials
 - Switch to undrained soils
 - Model sequence
 - Apply estimated undrained pore pressure profile to undrained materials (no movement)
 - Switch to drained parameters (no movement)
 - Switch to long term pore pressures
- FREW will calculate undrained pore pressure profile based on Mohr Coulomb or modified Cam Clay model
- Need to assign undrained materials pore pressure calculation on

													Tokal skress
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0.361	2.770	1.202	3.329	0.250	0.00	0.00	0.00	0.00	Drained				
0.422	2.371	1.299	3.080	0.250	0.00	0.00	0.00	0.00	Drained				

Modelling props

- A prop with:
 - pre-stress and no stiffness is an applied force
 - stiffness, k, only is a spring: $F = k\delta$
- To apply:
 - A moment restraint, apply a spring with 90° angle and a 1m lever arm
 - A moment, apply a force with 90° angle and a 1m lever arm
- Only horizontal & moment component is taken into account

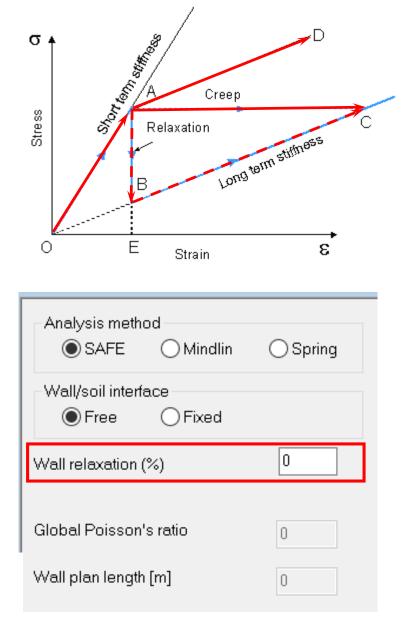
Strut	Sta	ige	Level	Prestress	Stiffness	Angle	Lever arm	
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Defaults								
1	2	3	28.000	200.00	0.00	40.00	0.30	
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3	4		30.000	0.00	30000.00	0.00	0.00	
4	4		24.700	0.00	30000.00	0.00	0.00	
5								



Relaxation and Creep

- Creep strain at constant stress
- FREW uses a tangent modulus, so can't just change stiffness
- Wall relaxation is specified in Analysis Data – Wall EI and stress in wall is reduced by specified percentage (AB)
- System is then out of equilibrium and has to move (BC)
- Similar effect required for props, but is not automatic. Initially need to install two props (of k/2). At creep stage, remove one of the props

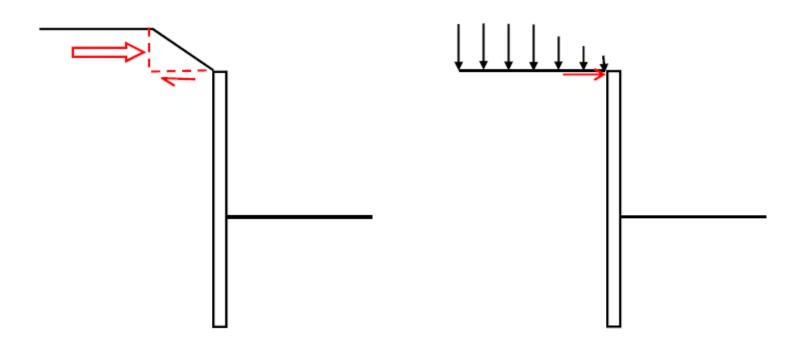
$$Relaxation = \left(\frac{Long \ Term \ EI - Short \ Term \ EI}{Long \ Term \ EI}\right) \times 100$$





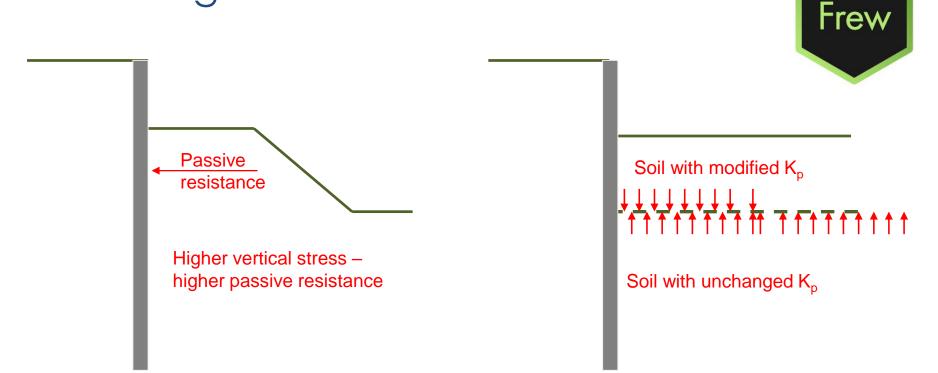
Modelling Sloping Ground

- For slopes of limited extent, may consider modelling as a surcharge.
- However, need to include a lateral force at top of wall





Modelling Berms



- 1. Simplified method (FREW Manual)
 - Calculate reduced K_p, for berm soil
 - Elastic effect of excavation modelled, but berm weight does not contribute to passive resistance in soil beneath berm
- 2. Rigorous method based on calculating revised $K_{\rm p}$ using method of slices



Modelling Berms

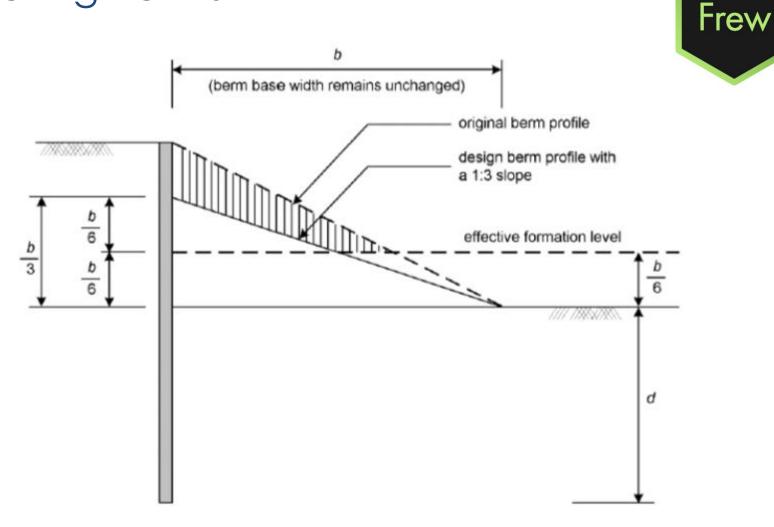
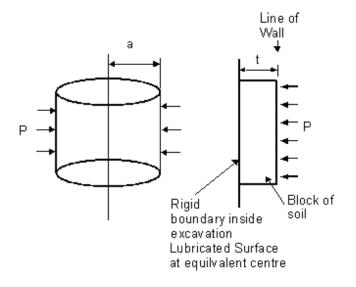
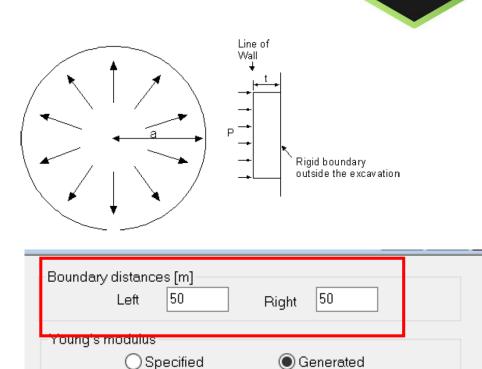


FIGURE 7.3 Representation of a berm by means of a raised effective formation level (after Fleming et al, 1994)



Modelling Shafts





- Frew analyses plane strain problem infinitely long excavation
- Axi-symmetric problem apply rigid boundary distance that gives equivalent displacements in a cylinder and a soil block

		-	
Youngs modulus d	ata		
Value (at	Left	Right	
Value (at bottom node)	0	0	
Gradient	Ω	0	
Gradient	U	U	



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Thermal Effects

- Expansion and contraction of slabs/props due to temperature effects can have significant consequences
- Effect is an applied strain: $\Delta L = \alpha . \Delta t. L$ $\alpha =$ thermal coefficient of expansion
- Fixed end Force: $\Delta P_{temp} = \alpha . \Delta t. E. A.$
- If wall is *rigid*, applied force = ΔP_{temp} . If wall is *flexible*, force = 0 and displacement = ΔL
- Model as a prop with stiffness $k = \Delta P_{temp} / \Delta L$, and prestress $-\Delta L$ (i.e. tension).
- Need additional prop which is equilibrium force from previous stage.
- Does not model soil "ratcheting" of integral bridges



Modelling methods

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Covered in previous webinar:

• Partial Factor Analysis (EC7)





Integral Bridge Analysis

- Section 9 and Annex A of PD 6694-1 cover Integral Bridges
- Based on BA42, but updated to:
 - align with Eurocodes
 - address known issues with BA42
 - embrace latest research in the field
- Some important developments that:
 - enhance efficiency in design
 - provide greater flexibility to designers

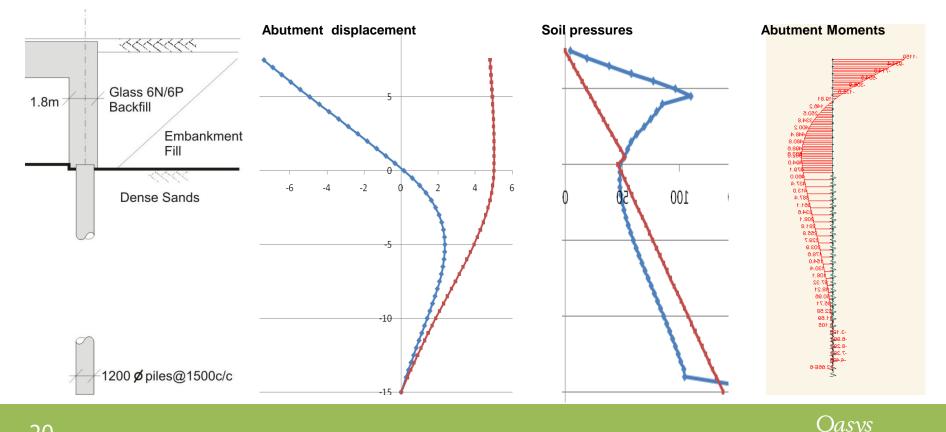




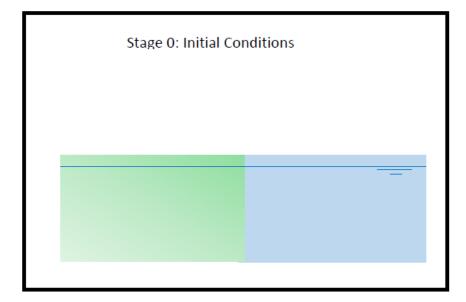
Integral Bridge Theory

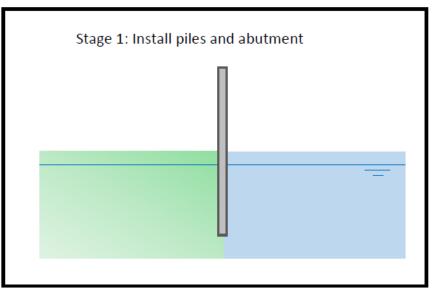
For flexible abutments, soil pressure is a function of the displacement of the abutment which is a function of the soil stiffness.

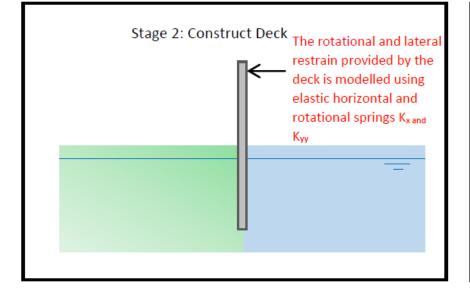
Soil Structure Interaction Required

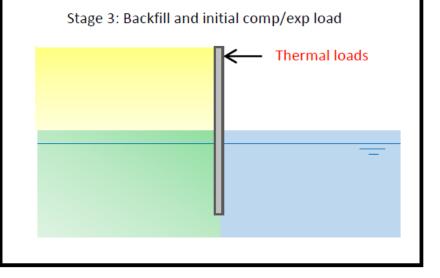














Seismic Design Considerations

Retaining Walls:

- Dynamic Earth Pressure
- Dynamic Water Pressure
- Load Factors





Literature

- Steedman (1998)
- Design Framework from PIANC (2001)
- EC8

Seismic design of retaining walls

R. S. Stredman, &Sr. MPuil, Pub. CEng. FICE, FRSA

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Introduction

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Methods



Define wall-soil-system:

EITHER Perfectly Rigid / No Displacement Wood's

OR Wall free to displace until min (active) earth pressures occur

Mononobe-Okabe



Features

- Automatically calculates parameters to Eurocode 8
- Incorporates Mononobe-Okabe and Woods methods
- Kh values can be user defined to comply with other codes

Seismic Analys	sis to Eurocode 8			1		
Analysis meth	od	Design groun	Design ground acceleration [m/s²]			
Mo	nonobe-Okabe	Gravity accele	9.81			
⊖Wo	ods	Kv ratio (Kv/Kh	0			
Apply M-O Kp	as passive limit	Soil S Value (f	for calculated Kh)	1.4		
Seismic load a	application method					
Soil: Obistributed load		50	% at base to 150.00%	at top		
	Point load at height fxH	l from base - f =	0.5			
Groundwater:	O Distributed load					
	Point load at height fxF	l' from base - f =	0.333333			
Select gen	erated seismic load type	None		\sim		
	Apply		Undo			

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Training and Support

- Tutorial Manual
- User Manual
- Tutorial Videos
- Previous Webinars
 - Tips and Tricks
 - Partial Factors
- Email Support (analysis file and images)
- Training Sessions





Using Frew from home



- Run the analysis file locally (not on a remote network)
- Use the backup feature
 - Tools>Preferences
- Are you using the most recent Build?
 - Help>About Oasys
- To manage your license, use the license portal





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Session 1 – Introduction to Methodology and setting up a model



Any Questions?

