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Christopher Matthews

Atelier One

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11/11/2020

Re. Greville Street Tunnel Assessment

Dear Christopher

We have carried out a greenfield ground movement assessment to advise on the predicted ground settlement, radius of curvature and distortion affecting the Crossrail tunnel underlying the Greville Street site.

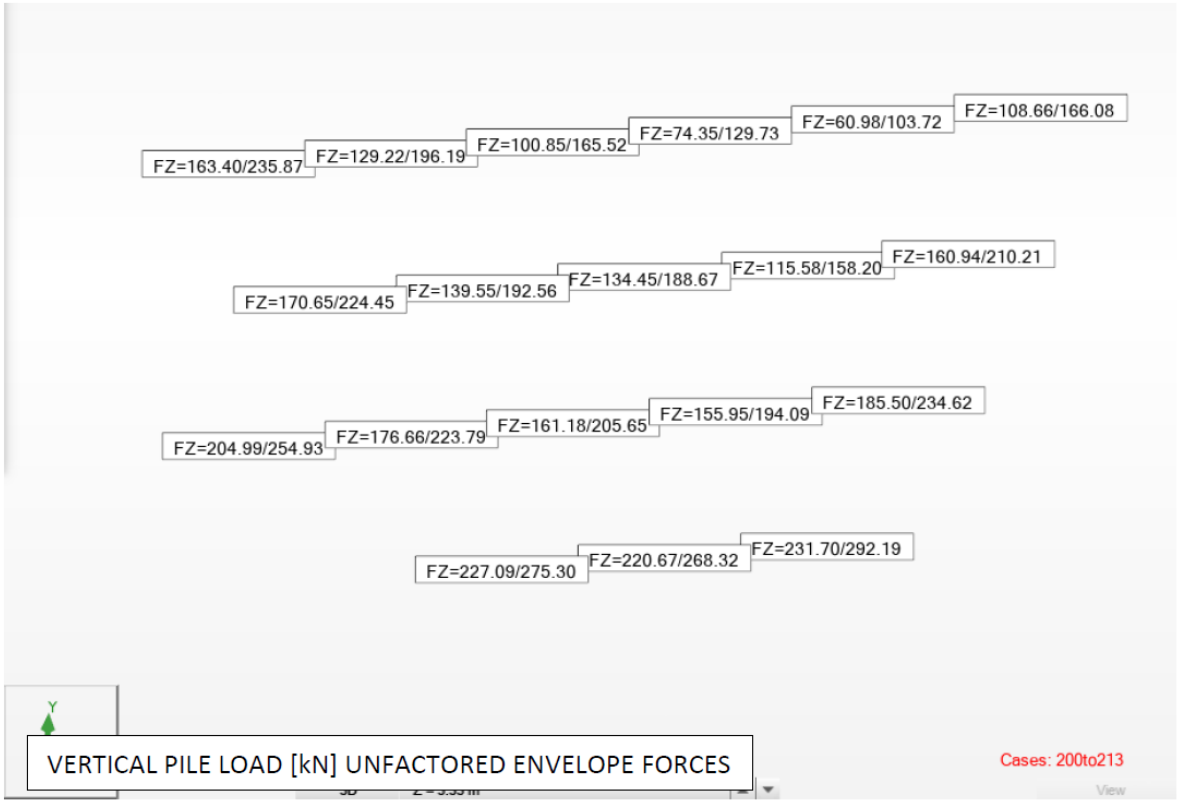
Using PDisp, we analysed a greenfield model of the piled option assuming 15m deep piles and used the unfactored loading provided by Atelier One. The model does not include loading from the existing buildings nor does it include the stiffness of the tunnel itself. We would expect that if we included additional structural elements to the model the predicted settlement would be less. We found that the maximum settlement affecting the top of the tunnel is approximately 4mm.

We calculated that the radius of curvature is greater than 10km and therefore it meets the Crossrail tunnel curvature criterion (Crossrail information for developers March 2019.pdf, Section 5.2.1).

The vertical distortion was calculated based on the difference in movement between the top and the bottom of the tunnel. The movement at the top of the tunnel is approximately 2mm greater than the movement at the bottom of the tunnel, creating a squatting distortion. The distortion of 2mm is 0.03% of the tunnel's external diameter.

The analysis inputs and results are summarised below:

1. Pile loads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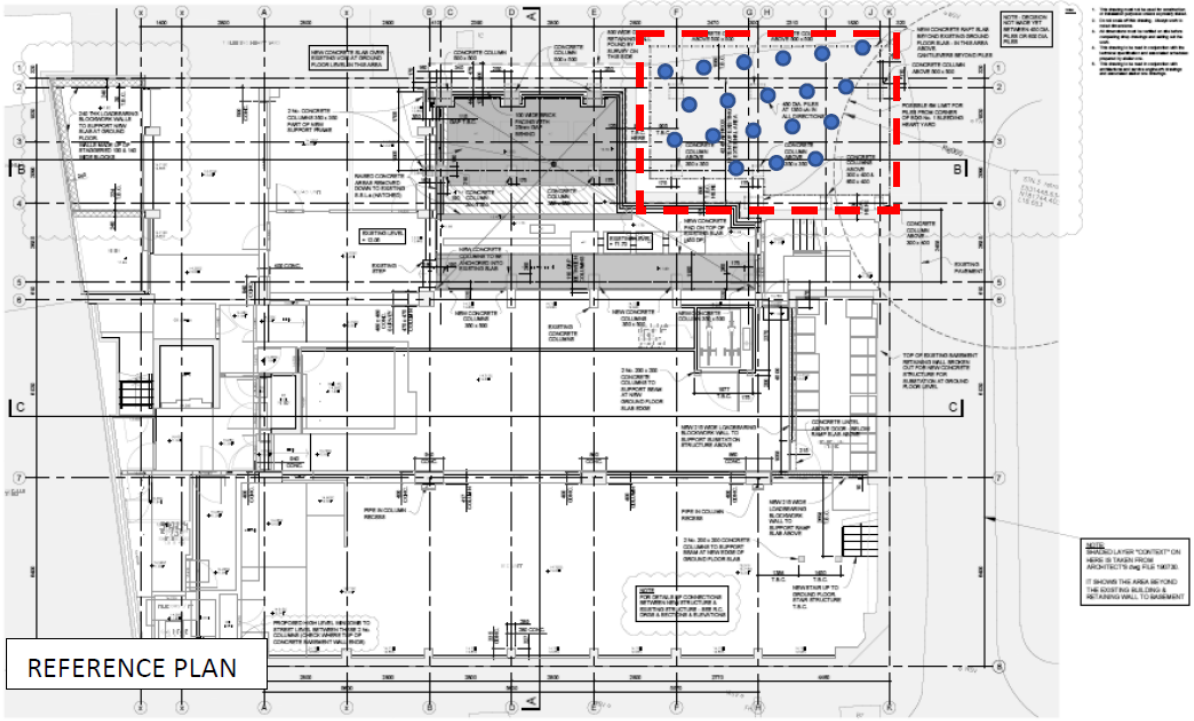
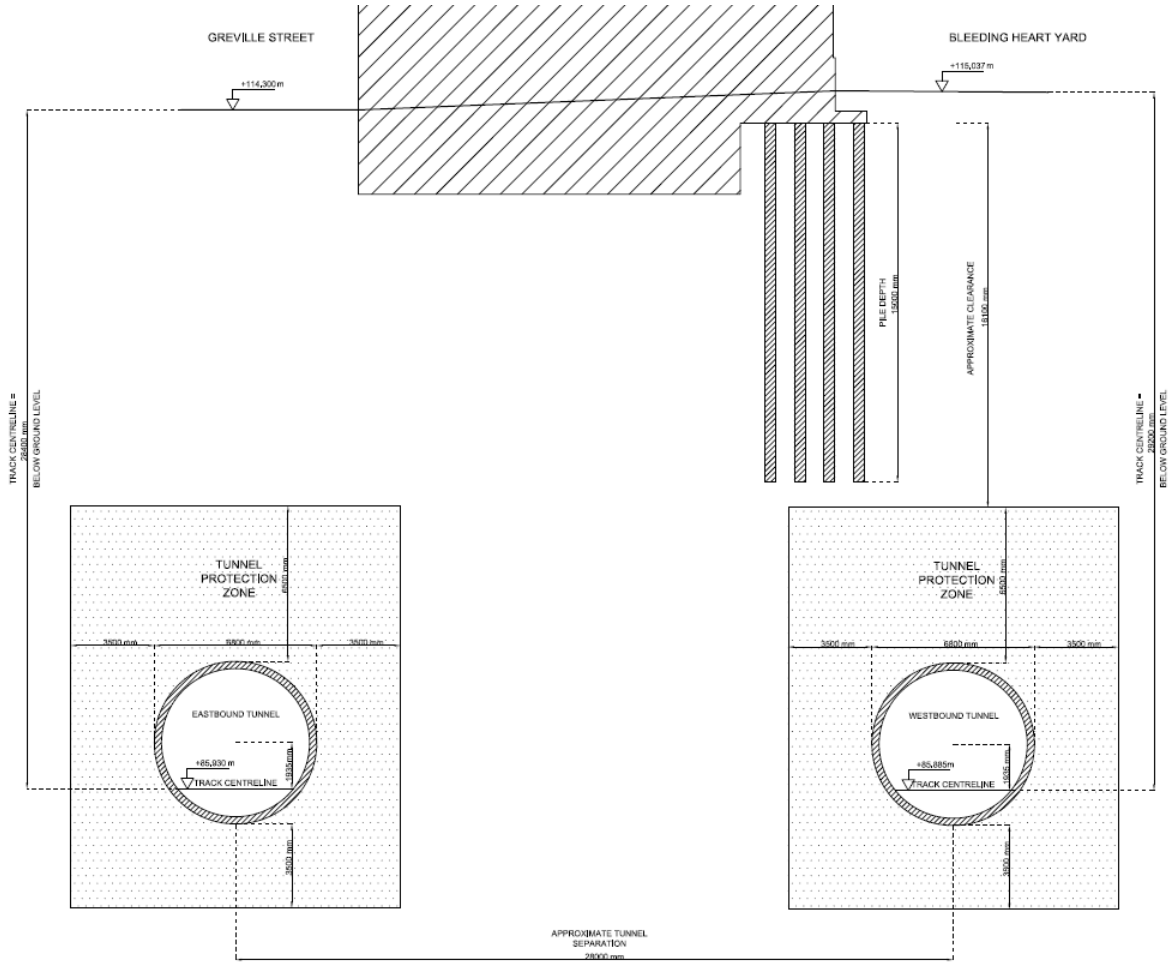
FZ=185.50/234.62
FZ=227.09/275.30
FZ=220.67/268.32
FZ=231.70/292.19
VERTICAL PILE LOAD [kN] UNFACTORED ENVELOPE FORCES
Cases: 200to213


REFERENCE PLAN

2. Tunnel details:

We assumed the top of tunnel is at 22.1m and the bottom of the tunnel at 28.9m below the top of the piles and that the external diameter of the tunnel is 6.8m; as per the drawing below:



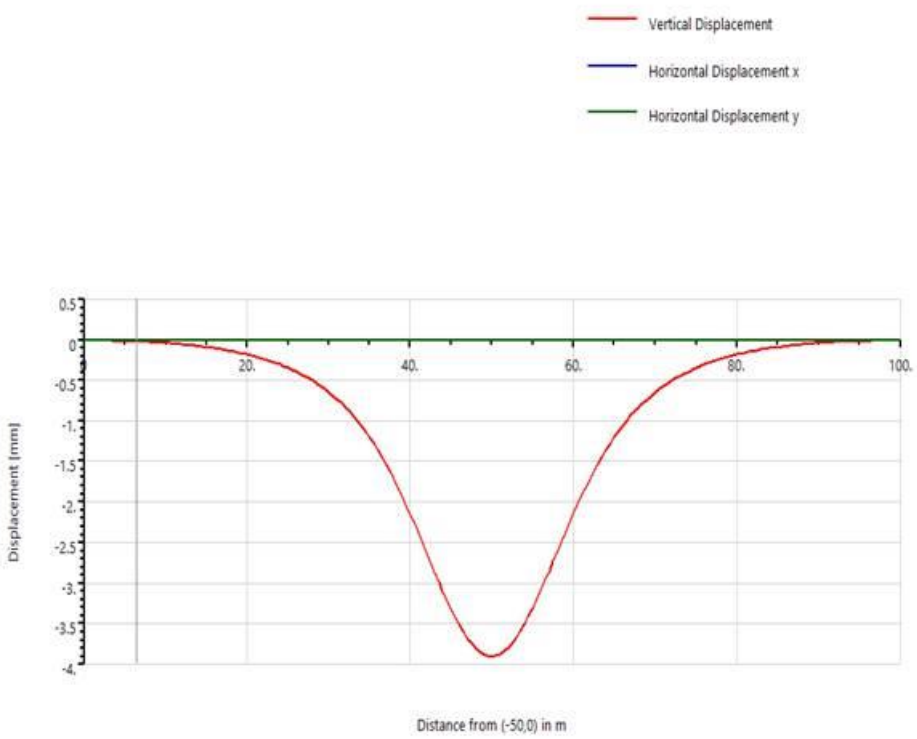
3. Soil Profile using drained conditions:

Tunnel assessment : Soil Profiles

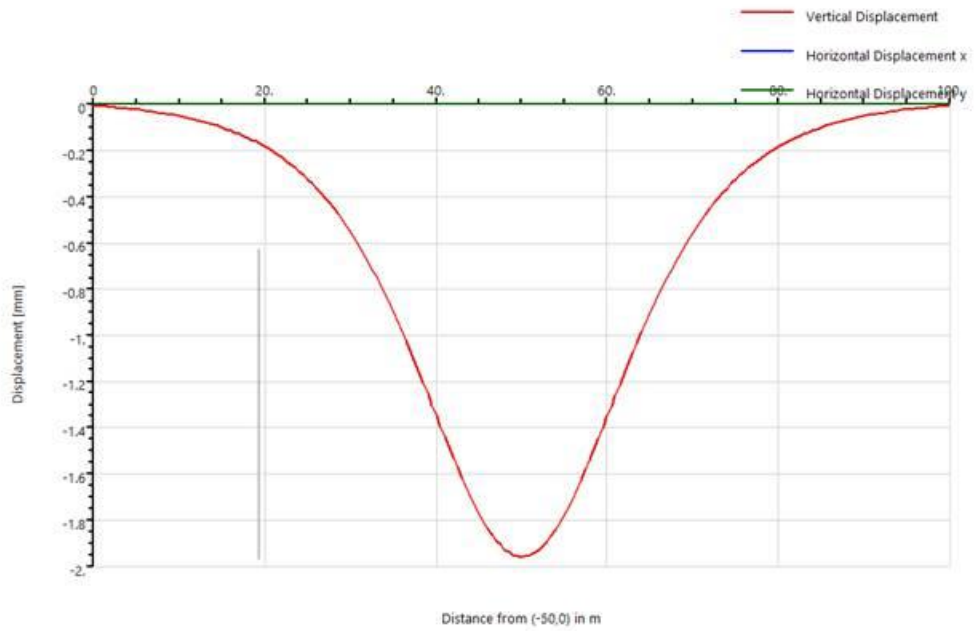
Layer ref.	Name	Level at top	No of intermediate displacement levels	Young's modulus		Poisson's ratio	Colour
				Top	Bottom		
		[m]		[kN/m²]	[kN/m²]		
Defaults	Layer #	0.000	5	50000	50000	0.200	
1	Made Ground	0.000	5	10000	10000	0.300	
2	River Terrace Deposi	-3.100	5	25000	25000	0.300	
3	Weathered London	-3.400	5	19000	19000	0.400	
4	Weathered London	-4.000	5	28000	28000	0.400	
5	London Clay	-8.000	5	28300	28300	0.400	
6							

4. Displacement results:

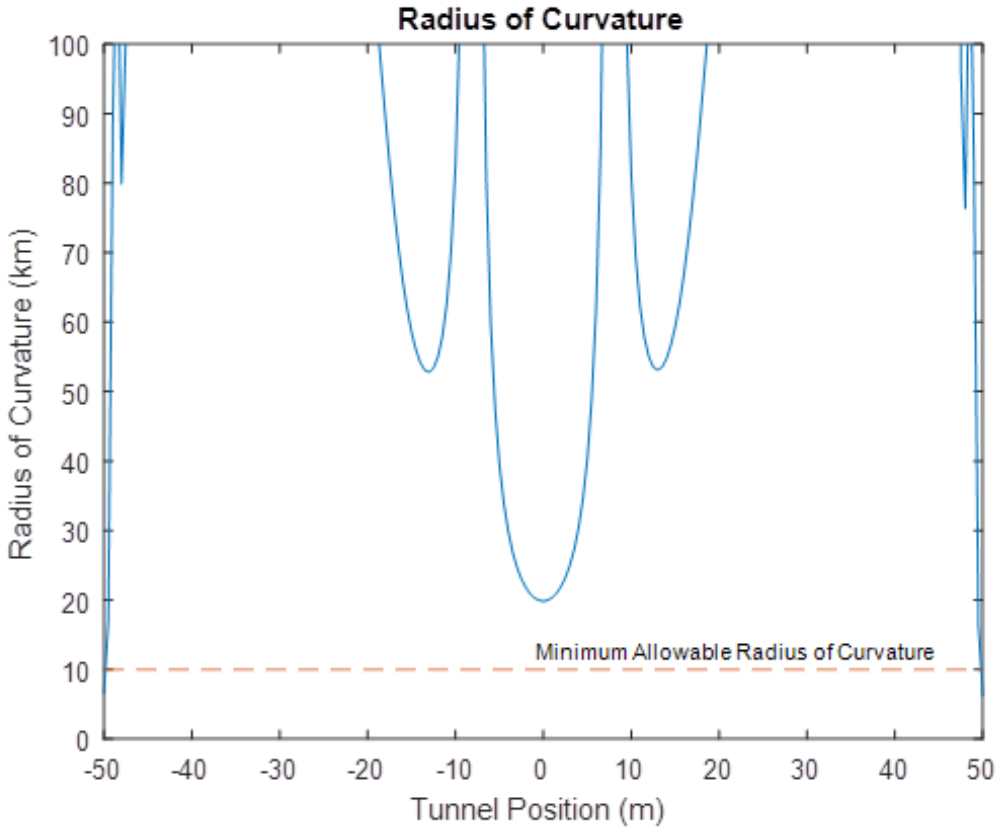
Displacement for Top of tunnel



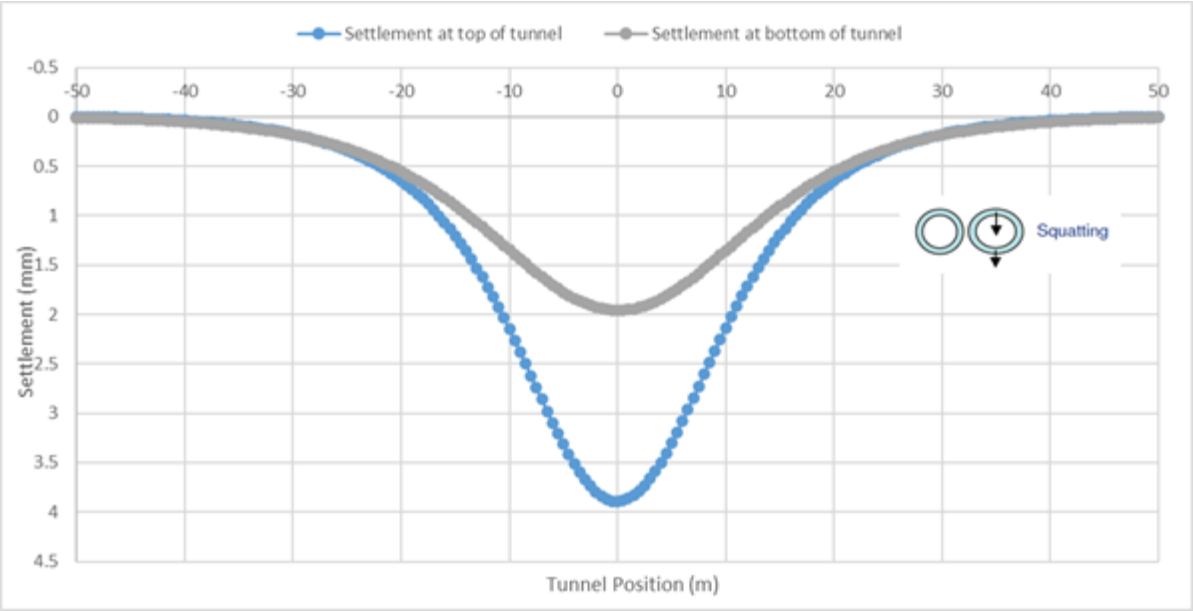
Displacement for Bottom of tunnel



5. **Radius of curvature (always greater than 10km):**



6. **Distortion (maximum distortion of 0.03% of the tunnel's external diameter):**



Yours sincerely

for

Gavin and Doherty Geosolutions

Clare Brennan

Senior Engineer

cc Neil Smith