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Northern Line Tunnel Impact Assessment

in relation to

Proposed New 4-Storey Residential & Commercial Development

at

3,5 & 7 Fortress Road Kentish Town, London, NW51AA

on behalf of

Mr. Mario Tyrimou

Document History and Status

Revision	Status	By	Approved	Date
01	First Issue	AMA	MO'R	13th April, 2023

Contents

1.0 Introduction

Planning permission has been granted for the redevelopment of the existing mixed use property at 3, 5 and 7 Fortess Road London, NW5. It is proposed to deconstruct the existing and now derelict three storey building and replace with a new four storey building that contains retail units on ground floor and residential accommodation on the upper floors.

The running tunnels of the Northern Line lie approximately 8m to the east of the building beneath Fortess Road, London NW5.

Ross and Partners are the appointed Structural Engineers for the building and this report has been prepared to consider the impact that this construction may have on the Northern Line tube tunnels.

We have contacted London Underground (LUL) and they have provided us with approximate location of northern line tunnels in relation to the site. The drawing plan shows north bound tunnel crown approximately 17.4m below ground level and South bound tunnel crown approximately 23.2 m below ground level. By interpolation both depths we have taken the tunnel crown perpendicular to site at 20m and distance of approximately 8m horizontally from the front entrance to the tunnel.

The new building is proposed to be constructed from light structural materials in order to maintain a similar overall weight of building and reduce the potential for changes in tunnel stress and tunnel movements. Our assessment calculate the overall change in stress at the tunnel crown arising from the redevelopment to be small at 0.1%.

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Site Context

Fortess Road provides a direct vehicular and pedestrian route between Kentish Town and Tufnell Park Stations in a south the north-south direction. The running tunnels of the Northern Line also run beneath the road between these two stations. The site location is highlighted below and is located on the western side of the road.

Site Location

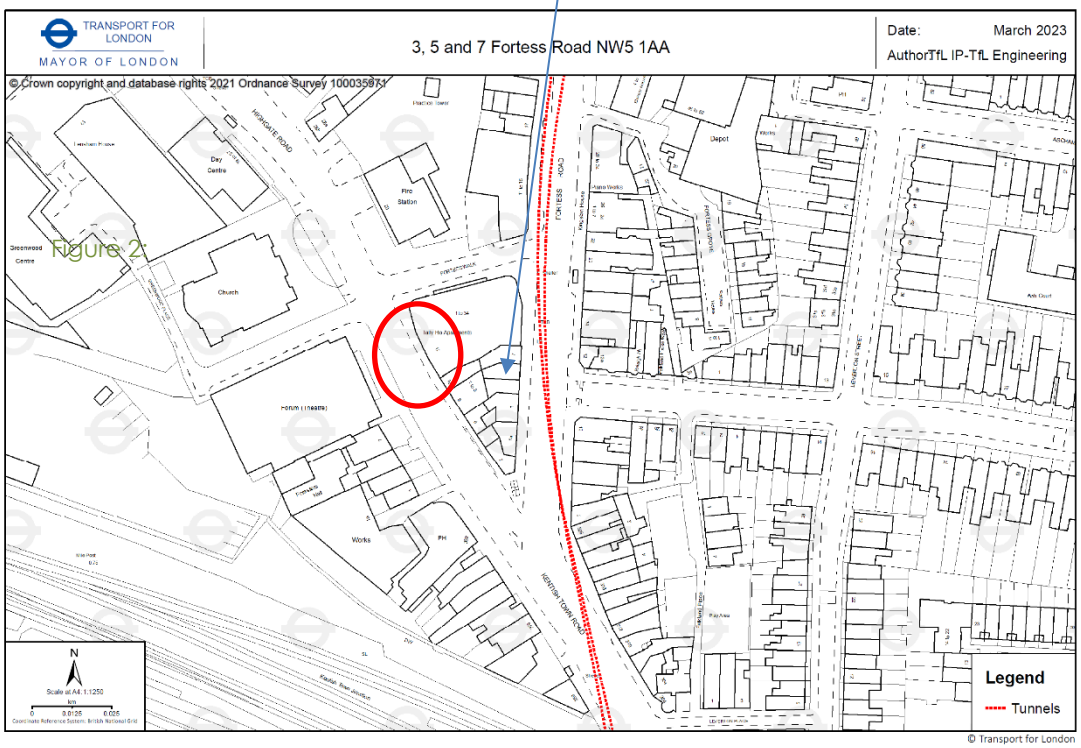


Figure 1: Site Location

Figure 2:

Existing Building

The existing building is believed to date from the late 19th century; which approximates to the time of the tunnels construction. Although disused for some time and in a state of disrepair, the property has for many years served as a mixed use of ground floor retail and upper residential floors.

The building is formed of a construction arrangement and materials that are typical for the late nineteenth century with brick masonry walls and suspended timber floors and roof. The ground floor is formed of a solid slab and the foundations are believed to be shallow strip brick corbelled footings.

Figure 3: the front elevation of existing building using google maps.

Proposed Building

The proposed new building will have retail accommodation at ground floor and three upper floors of residential accommodation. Like the existing property, the new building will occupy the entire footprint of the site but have one additional floor. The structural option envisaged is a steel frame consisting of shallow steel beams and steel columns supported by shallow reinforced concrete foundations. The floors will be formed using standard timber joists with cavity wall facade around the perimeter of the building.

Figure 3: the front elevation of proposed building

2.0 LUL Infrastructure.

The route of the Northern Lines tunnels is Figure 4 &5 below. The northern line tube tunnels are approximately 8m to the east of the property a mean depth of 20m. The diagrams indicate the tunnel alignment to follow a very gentle curve.

The tunnels and stations at Kentish Town and Tufnell Park were opened in 1907 by the Charing Cross, Euston and Hampstead Railway. The tunnels are of circular cast iron segmental lining construction with a dimeter of 11‘ 8”.

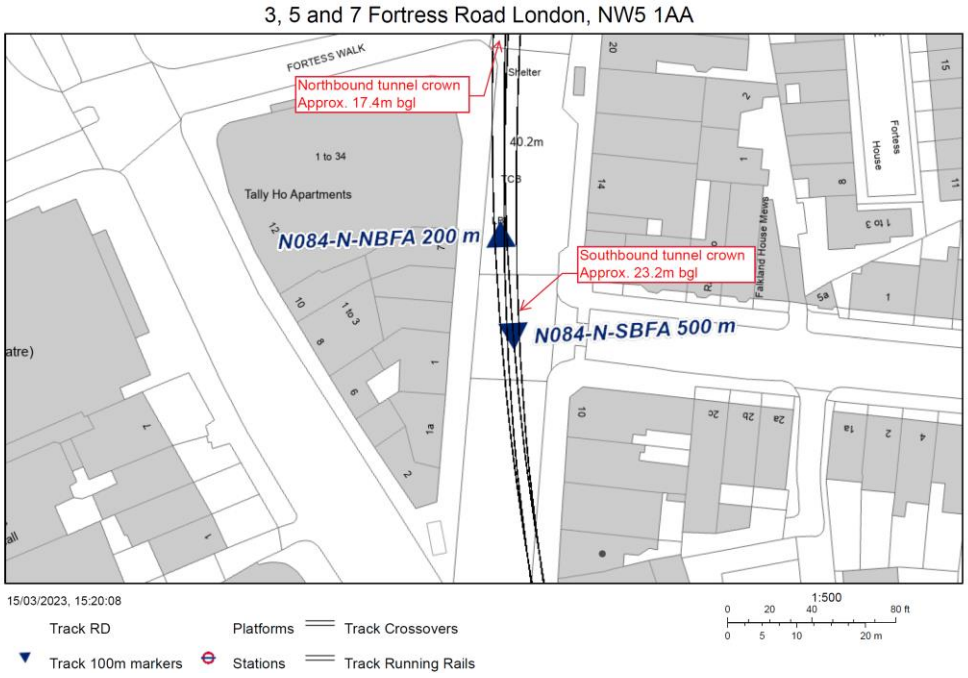


Figure 4: Indicative Site Plan courtesy of London Underground Ltd.

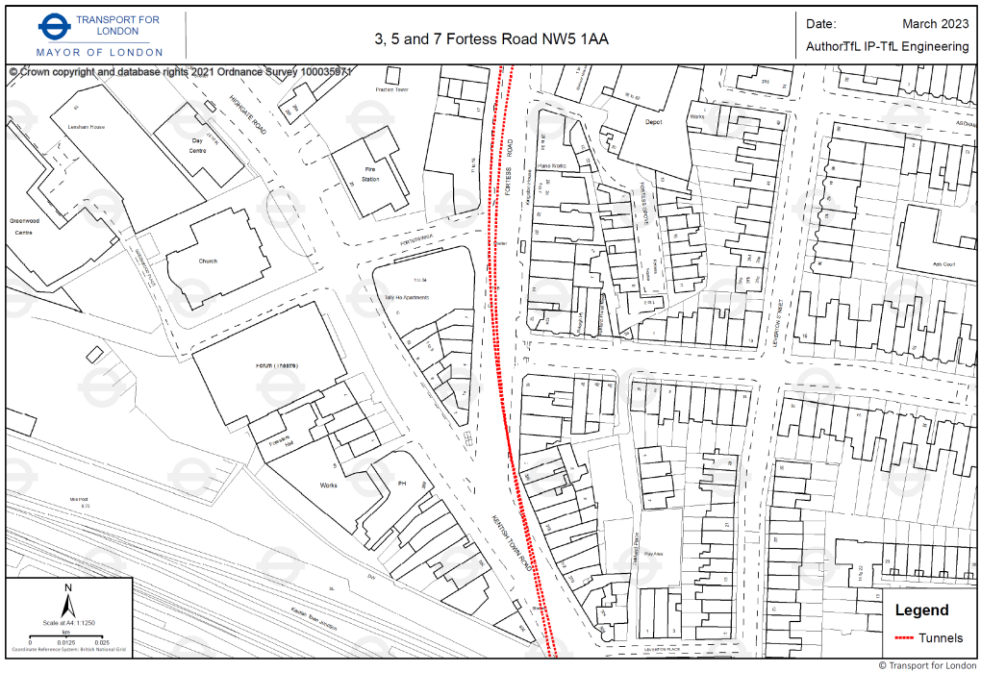
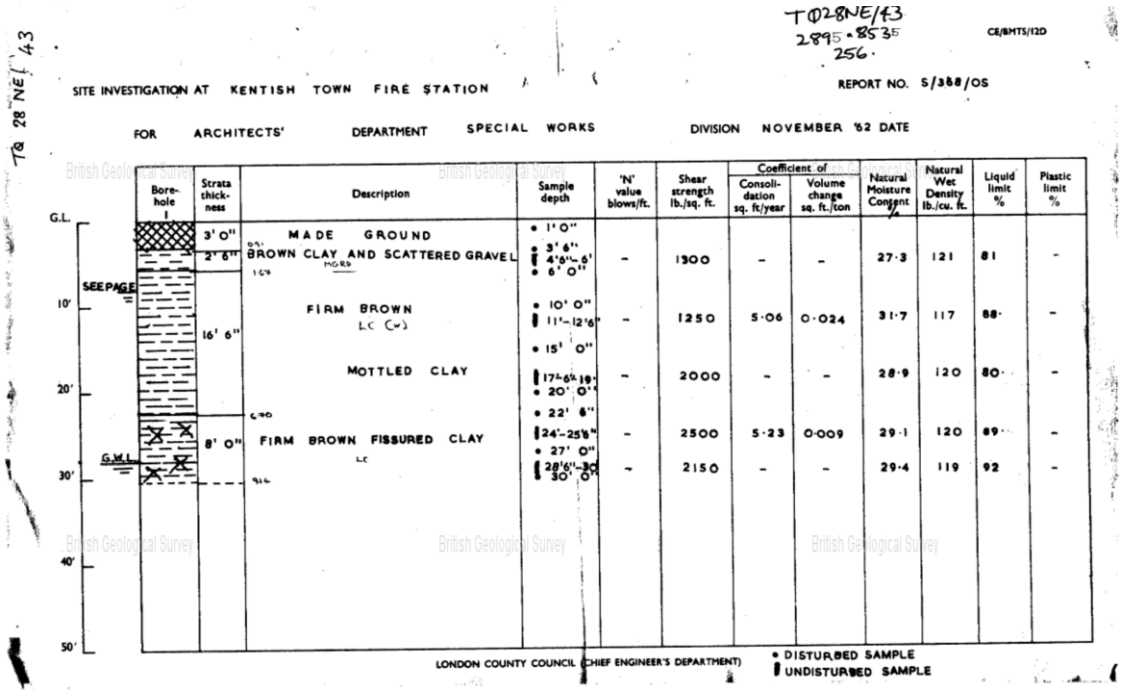


Figure 5: Indicative tunnel position courtesy of London Underground Ltd.

3.0 Site Geology

The ground conditions have been derived from the British Geological Survey indicates the site to be underlain by 1m of Made Ground Deposits above the solid geology of the London Clay Formation.

Information from BGS Borehole records at close proximity to site indicates the solid geology to be the London Clay formation, comprises from Made Ground, Brown Clay & gravel, Firm Brown clay, Mottled clay and firm brown fissured clay.



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SITE INVESTIGATION AT KENTISH TOWN FIRE STATION — REPORT NO. S/388/OS

FOR ARCHITECTS' DEPARTMENT SPECIAL WORKS DIVISION NOVEMBER '62 DATE

Bore-hole	Strata thick-ness	Description	Sample depth	'N' value blows/ft.	Shear strength lb./sq. ft.	Coefficient of Consoli-dation sq. ft/year	Coefficient of Volume change sq. ft./ton	Natural Moisture Content %	Natural Wet Density lb./cu. ft.	Liquid limit %	Plastic limit %
	3' 0"	MADE GROUND	• 1' 0"								
	2' 6"	BROWN CLAY AND SCATTERED GRAVEL	• 3' 6" 4'6"–5'	-	1300	-	-	27·3	121	81	-
			• 6' 0"								
SEEPAGE	16' 6"	FIRM BROWN LC (w)	• 10' 0" 11'–12'6"	-	1250	5·06	0·024	31·7	117	88·	-
		MOTTLED CLAY	• 15' 0" 17'–18'	-	2000	-	-	28·9	120	80·	-
			• 20' 0"								
			• 22' 6"								
G.W.L.	8' 0"	FIRM BROWN FISSURED CLAY LC	24'–25'6" • 27' 0"	-	2500	5·23	0·009	29·1	120	89·	-
			28'6"–30' 30' 0"	-	2150	-	-	29·4	119	92	-

G.L. 10' 20' 30' 40' 50'

LONDON COUNTY COUNCIL (CHIEF ENGINEER'S DEPARTMENT)

• DISTURBED SAMPLE
UNDISTURBED SAMPLE

Table 1:Shows the nearby archive borehole record from BGS.

As per the BGS Borehole record the ground water level is expected to be encountered at approximately 7.11mbgl.

4.0 Impact on tunnels

From the available data, the crown of the North bound Northern Line Tunnel is believed to be at least 17.4m below ground level and the crown of the South bound Northern Line Tunnel is believed to be at least 23.3m below ground level. By interpolation both depths we have taken the tunnel crown perpendicular to site at 20m.

For the purposes of determining the ground stresses at the crown of the tunnels a unit weight of 20KN/m^3 has been adopted for the London Clay.

Existing Condition above the Crown of the Tunnels

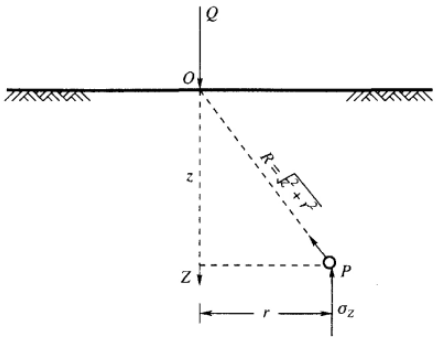
The vertical stress at the crown of the tunnels is equal to the overburden stress plus an allowance for vehicular loading:

Overburden stress	400.00 kPa

Applied stress from the existing building to the Tunnel.

The total load of the existing building has is calculated to be 4933.64 kN.

Applying Boussinesq's formula for determining the stress at depth z resulting from a surface point load Q,



At point P of above figure due to a point load Q,

$$Vertical\ stress, \sigma_z = \frac{3Q}{2\pi z^2} \frac{1}{[1+(r/z)^2]^{5/2}} = \frac{Q}{z^2} I_B$$

where,

r = the horizontal distance between an arbitrary point P below the surface and the vertical axis through the point load Q.

z = the vertical depth of the point P from the surface.

I_B = Boussinesq stress coefficient =

$$\frac{3}{2\pi} \frac{1}{[1+(r/z)^2]^{5/2}}$$

Q = 4933.64 KN
z = 20 m
r = 8 (Assumed)
I_B = 0.33

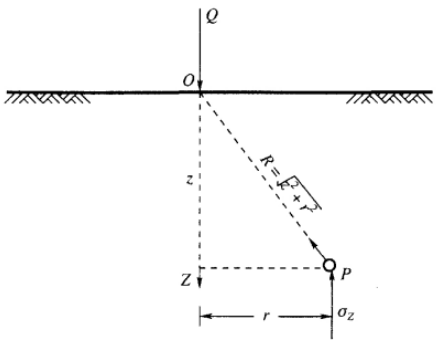
Giving σ = **4.07 KPa**

Therefore the total stress at the crown of the tunnel resulting from the overburden and the existing building is 404.07 KPa.

Applied stress from the proposed building to the Tunnel.

The total load of the proposed building has calculated to be 5440.47 kN.

Applying Boussinesq's formula for determining the stress at depth z resulting from a surface point load Q,



At point P of above figure due to a point load Q,

$$Vertical\ stress, \sigma_z = \frac{3Q}{2\pi z^2}\frac{1}{[1+(r/z)^2]^{5/2}} = \frac{Q}{z^2}I_B$$

where,

r = the horizontal distance between an arbitrary point P below the surface and the vertical axis through the point load Q.

z = the vertical depth of the point P from the surface.

I_B = Boussinesq stress coefficient =

$$\frac{3}{2\pi}\frac{1}{[1+(r/z)^2]^{5/2}}$$

Q = 5440.47 KN
z = 20 m
r = 8 (Assumed)
I_B = 0.33

Giving σ = **4.49 KPa**

Therefore the total stress at the crown of the tunnel resulting from the overburden and the existing building is 404.49 KPa.

5.0 Discussion of Results

The results have been prepared on the conservative assumption the stress at the crown of the tunnels is limited to that applied by the overburden and existing building only.

At this location the existing vertical overburden stress is 404.07 KPa.

The change in stress due to demolition unloading is 3.22KPa which is 0.80% of the existing stress.

After construction the component of stress applied to the tunnels is 4.49KPa which amounts to an overall increase in stress of 0.42kPa at the crown of the tunnel which is equal to 0.1% of the present stress at the crown of the tunnel.

These vertical stress changes are small and it is therefore reasoned:

- The stress in the tunnel linings will also be very small
- Any theoretical tunnel movements will be negligible.
- Given the shallow radius of track curvature clearances are unlikely to be an issue and the stress changes will not lead to any issues.

6.0 Conclusion

The demolition of the existing three storey building and construction of a new four storey building at 3,5 and 7 Fortress Road have been assessed in terms of their impact on LUL's Northern Line tunnels which run to the east of the property.

This assessment, based upon simple analyses concludes that:

- Tunnel clearances are unlikely to be affected
- The calculated stress changes are very small (max 0.8%) and are unlikely to have any significant impact on tunnel movements and tunnel structures and do not cause concern with respect to their structural integrity.

Appendix A

Fortress Road - Existing Building

Pitched Roof

Clay Tiles	0.70
Batten and Felt	0.07
Timber Rafters and Insulation	0.20
Total	0.97 (37°) = 1.22
Imposed	0.75
	$1.21_{gk} + 0.75_{qk}$ KN/m²

Flat Roof

Bitumen felt and Boarding	0.40
Plaster boarding plus skim	0.15
Timber Joist and Insulation	0.25
Imposed	0.75
	$0.80_{gk} + 0.75_{qk}$ KN/m²

Timber Floor

Floor Boarding	0.15
Lath and Plaster boarding plus skim	0.50
Timber Joist and Insulation	0.25
Partition	1.00
Imposed	1.50
	$1.90_{gk} + 1.50_{qk}$ KN/m²

Ground Floor

200mm Ground Bearing Slab	5.00
50mm Screed	1.20
Imposed	4.00
	$6.20_{gk} + 4.00_{qk}$ KN/m²

Brick Wall

225 Solid Brick Wall	4.5 KN/m²
325 Solid Brick Wall	6.5 KN/m²
300 Cavity Wall	4.5 KN/m²

Fortress Road - Proposed Building

Flat Roof Without Solar Panel

Bitumen felt and Boarding	0.20
Plaster boarding plus skim	0.15
Timber Joist and Insulation	0.25
Imposed	0.60
	$0.60_{gk} + 0.60_{qk}$ KN/m²

Flat Roof

Bitumen felt and Boarding	0.20
Plaster boarding plus skim	0.15
Timber Joist and Insulation	0.25
Solar Panels	0.15
Imposed	0.60
	$0.75_{gk} + 0.60_{qk}$ KN/m²

Timber Floor

Floor Boarding	0.15
2 sheet Plaster boarding plus skim	0.30
Timber Joist and Insulation	0.25
Partition	1.00
Imposed	1.50
	$1.70_{gk} + 1.50_{qk}$ KN/m²

Ground Floor

200mm Ground Bearing Slab	5.00
50mm Screed	1.20
Imposed	4.00
	$6.20_{gk} + 4.00_{qk}$ KN/m²

Brick Wall

300 Cavity Wall	4.5 KN/m²

Existing Building:

Main Pitched Roof = 14.7 x6.92 x 1.96= 199.38 kN

Rear Flat Roof = 0.5x 7.7x12.8 x1.55= 76.38 kN

Second Floor = 14x6.5 x3.4= 309.4 kN

First Floor = 14x6.5x3.4= 309.4 kN

Ground Floor = 14x6.5x10.2 =928.2 kN

Ground Floor Rear =0.5x 7.7x12.8 x10.2= 502.66 kN

Front Wall Ground -first = 14.72x 2.6 x 1 = 38.27 kN

Front Wall First -Roof = 14.72x 6.5 x 6.5 = 621.92 kN

Rear Wall Ground -Roof = 14.72x 8.8 x 4.5 = 582.92 kN

Party Wall Ground -Roof 4 (No)= 4x8.8x 6.5 x 4.5 = 1029.6 kN

Rear single storey wall = 3.1x12.85 x4.5= 179.26 kN

Rear single storey party wall 1 = 3.1x7.7 x4.5= 107.42 kN

Rear single storey party wall 2 = 3.1x3.5 x4.5=48.83 kN

Total Load = **4933.64 kN**

Proposed Building:

Main Flat Roof with solar Panel = 15 x6.6 x 1.35= 133.65 kN

Rear Flat Roof = 0.5x 7.7x13 x1.2= 60.06 kN

Third Floor = 15x6.6 x3.2= 316.8 kN

Second Floor = 15x6.6 x3.2= 316.8 kN

First Floor = 15x6.6 x3.2= 316.8 kN

Ground Floor = 15x6.6x10.2 =1009.8 kN

Ground Floor Rear =0.5x 7.7x13 x10.2= 510.51 kN

Front Wall Ground - Roof = 15x 14.5 x4.5 = 978.75 kN

Rear Wall First - Roof = 15x 9.2 x 4.5 = 621 kN

Party Wall Ground -Roof 2 (No)= 2x9.2x 6.7 x 4.5 = 554.76 kN

Party Wall Ground Floor 2 (No)= 2x4x 6.7 x 2.25 = 120.6kN

Rear single storey wall = 4.6x13 x4.5= 269.1 kN

Rear single storey party wall 1 = 4.6x7.7 x4.5= 159.39 kN

Rear single storey party wall 2 = 4.6x3.5 x4.5=72.45 kN

Total Load = **5440.47 kN**