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51 CALTHORPE STREET, LONDON, WC1X 0HH

Basement Impact Assessment – Revision C Version 5 – Volume 5 of 5

APPENDIX P

CALCULATION SHEET

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Project: 51 Calthorpe Street BIA	Sheet no. of Calc. no: P/1	Job No: P12-385 Checked by:
Subject: CLASSIFICATION OF VISIBLE DAMAGE ASSESSMENT	Made by: PMO REV. MARCH Date: 2017	Date:

Ground Movement Calculations for Proposed Basement at 51 Calthorpe Street

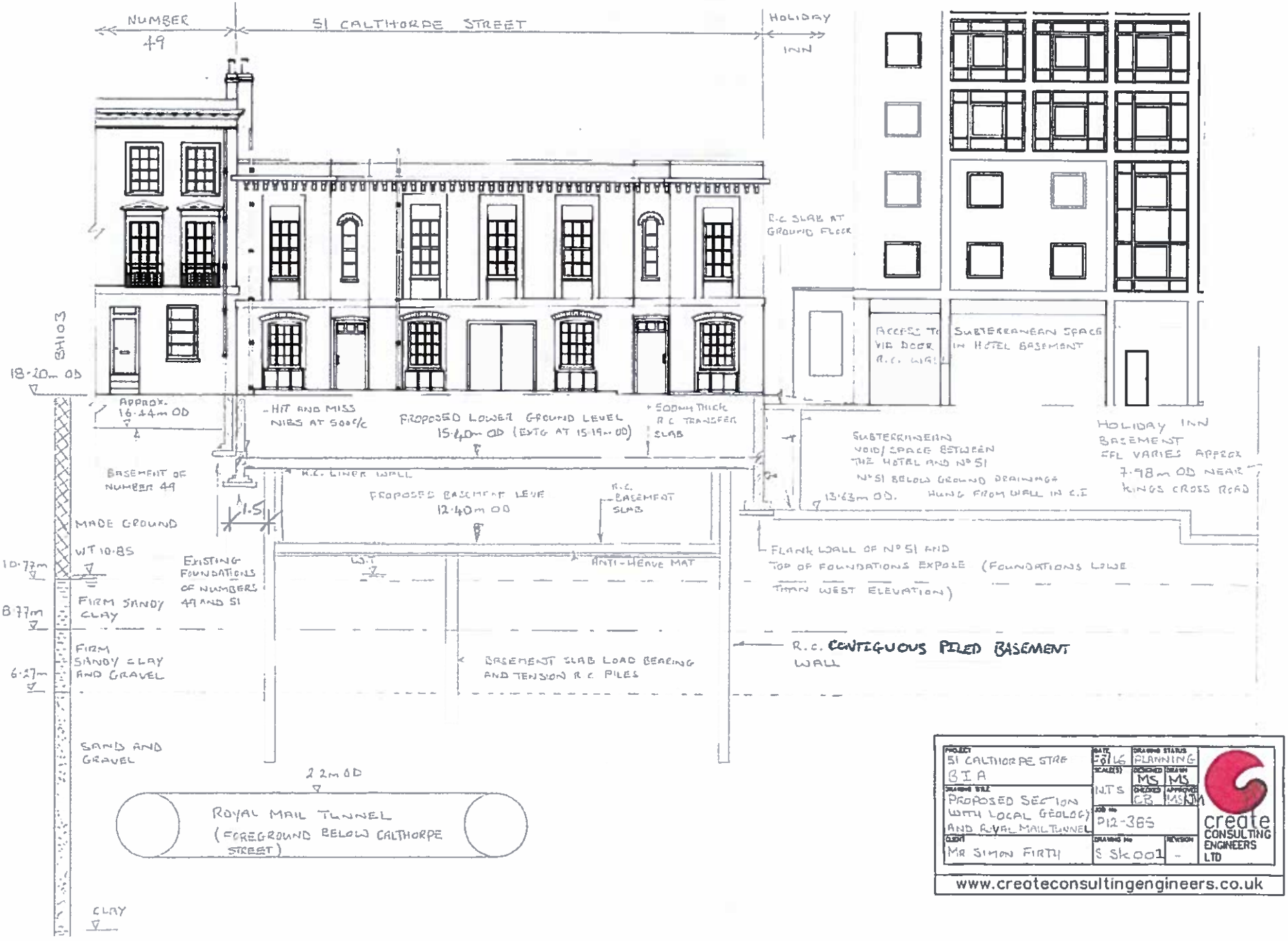
Ground movement estimates have been made using the guide CIRIA C580 Embedded Retaining Walls Guidance for Economic Design, Gaba et al., CIRIA, 2003. Some tables and graphs are reproduced in the calculations.

GROUND COMPRISES SANDY CLAYS & GRAVELS.

PILES ARE EMBEDDED INTO FIRM SANDY CLAY AND GRAVEL LAYERS.

GROUND IN EXCAVATED ZONE MADE - GROUND. MORE SANDY.

GROUND MOVEMENTS LIKELY BETWEEN THOSE IF STIFF CLAY ASSUMED AND FULL SAND CONDITION ASSUMED.



PROJECT: 51 CALTHORPE STRE BIA	DATE: Feb 16	DRAWING STATUS: PLANNING	create CONSULTING ENGINEERS LTD
DRAWING TITLE: PROPOSED SECTION WITH LOCAL GEOLOGY AND ROYAL MAIL TUNNEL	SCALE(S): N.T.S	DESIGNED: MS / DRAWN: MS / CHECKED: CB / APPROVED: MS JM	
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51 CALTHORPE ST. BIA

P/2

REV. MARCH 2017

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Project: 51 CALTHORPE STREET	Sheet no. of	Job No: P12-385
	Calc. no: P/3	Checked by:
Subject: GROUND MOVEMENT ASSESSMENT	Made by: PMO	Date:
	Date:	

GROUND MOVEMENT ASSESSMENT

THE CIRIA GUIDE C580 HAS BEEN USED TO ESTIMATE GROUND MOVEMENTS FOLLOWING THE METHODOLOGY OUTLINED IN SECTION 2.5.4. THIS IS SUMMARISED IN BOX 2.5 BELOW.

Box 2.5 *Procedure for stage 2 damage category assessment*

The following steps should be undertaken in making a stage 2 assessment of the damage to a structure:

(i) establish L and H for the structure (see Figure 2.18(a) for definitions of L and H)

(ii) determine (L/H)

(iii) determine relationship between (Δ/L) and ε_h for the required (L/H) from Figure 2.18(b) for ε_{lim} values from Table 2.5

(iv) estimate vertical and horizontal ground surface movements in the vicinity of the structure from Figure 2.14

(v) determine (Δ/L) and ε_h $(= \delta_h/L)$ where δ_h is the horizontal movement

(vi) estimate damage category from the relationship between (Δ/L) and ε_h established from step (iii) above.

GROUND MOVEMENTS DUE TO PILE INSTALLATION

THE WALL COMPRISES A CONTIGUOUS PILE WALL WITH REINFORCED CONCRETE LINER WALL. THE DEPTH OF PILES IS 10m. HORIZONTAL AND VERTICAL MOVEMENTS ARE CALCULATED USING THE TABLES AND FIGURES IN SECTION 2.5 OF CIRIA C580.

GROUND MOVEMENTS FROM EXCAVATION IN FRONT OF WALL

CIRIA C580 GIVES GUIDANCE ON ESTIMATING GROUND MOVEMENTS DUE TO EXCAVATION IN FRONT OF A WALL IN SAND ON FIGURE 2.12. HOWEVER, MOST OF THE DATA FOR THIS GRAPH COMES FROM EITHER KING POST OR SHEET PILED WALLS. IN THE CASE OF 51 CALTHORPE STREET, WHICH HAS CONTIGUOUS PILED WALLS AND UTILISES TOP-DOWN CONSTRUCTION, EXAMINING THE DATA FOR THE DIAPHRAGM WALL CASE, WHICH BEST MATCHES WITH THE CASE AT 51 CALTHORPE ST, THE CURVE OF GROUND MOVEMENTS ACTUALLY FITS VERY CLOSELY TO THOSE ASSOCIATED WITH EXCAVATING IN STIFF CLAY, AS PER FIGURE 2.11. THEREFORE, THE VERTICAL MOVEMENTS DUE TO EXCAVATING IN FRONT OF THE WALL HAVE BEEN ASSESSED USING ONLY FIG. 2.11, I.E. ASSUMING EXCAVATING IN STIFF CLAY.
REFER TO PAGE P/7 FOR FURTHER DETAILS.

CALCULATION SHEET

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Project: 51 Calthorpe Street BIA	Sheet no. of	Job No: P12-385
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Subject: CLASSIFICATION OF VISIBLE DAMAGE ASSESSMENT	Made by: PMO REV. MARCH 17	Date:
	Date: 09/09/16	

Horizontal Movement Due to Bored Piles CONTIGUOUS PILE WALL

Depth of bored Piles = 10m

Table 2.2 *Ground surface movements due to bored pile and diaphragm wall installation in stiff clay*

Wall type	Horizontal movements		Vertical movements	
	Surface movement at wall (per cent of wall depth)	Distance behind wall to negligible movement (multiple of wall depth)	Surface movement at wall (per cent of wall depth)	Distance behind wall to negligible movement (multiple of wall depth)
Bored piles				
Contiguous	0.04	1.5	0.04	2
Secant	0.08	1.5	0.05	2
Diaphragm walls				
Planar	0.05	1.5	0.05	1.5
Counterfort	0.1	1.5	0.05	1.5

Notes

1. Maximum surface movement occurs close to the wall and is calculated as a percentage of the pile depth/diaphragm wall trench depth, as appropriate.
2. Extent of movement is calculated non-dimensionally by dividing by the pile depth diaphragm wall trench depth, as appropriate

Table 2.3 *Support stiffness categories (Carder, 1995)*

Support stiffness	Description/examples
High	*Top-down construction*, temporary props installed before permanent props at *high* level
Moderate	Temporary props of high stiffness installed before permanent props at *low* level
Low	*Cantilever walls*, temporary props of *low* stiffness or temporary props installed at low level

Table 2.4 *Ground surface movements due to excavation in front of bored pile, diaphragm wall and sheet pile walls wholly embedded in stiff clays*

Movement type	High support stiffness (high propped wall, top-down construction)		Low support stiffness (cantilever or low-stiffness temporary props or temporary props installed at low level)	
	Surface movement at wall (per cent of max excavation depth)	Distance behind wall to negligible movement (multiple of max excavation depth)	Surface movement at wall (per cent of max excavation depth)	Distance behind wall to negligible movement (multiple of max excavation depth)
Horizontal	0.15	4	0.4	4
Vertical	0.1 – CONSERVATIVE	3.5	0.35	4

- ALSO SEE FIG. 2.12 - MOVEMENTS IN SAND

CALCULATION SHEET

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Project: 51 CALTHORPE STREET	Sheet no. of	Job No: P12-385
	Calc. no: P/5	Checked by:
Subject: GROUND MOVEMENT	Made by: PMO Date: REV. MARCH 2017	Date:

HORIZONTAL MOVEMENT - CIRIA C580 EMBEDDED RETAINING WALLS -

GROUND SURFACE MOVEMENT DUE TO BORED PILES

PROPOSED BASEMENT DEPTH =
DEPTH = 3.0m BELOW EXISTING B'MENT / NEW LOWER GROUND LEVEL.
DEPTH OF PILES = 10m APPROX.

TABLE 2.2

CONTIG. WALL
HORIZ. SURFACE MOVEMENT = 0.04%
δ_h = 4.0mm
DIST. TO NEG. MOVEMENT = 1.5x 10 = 15m

VERT. SURFACE MOVEMENT = 0.04%
δ_v = 4mm
DIST. TO NEG. MOVEMENT = 2x 10 = 20m

POTENTIAL MOVEMENT DUE TO WALL EXCAVATION

TABLE 2.3

HIGH SUPPORT STIFFNESS - TOP DOWN CONSTRUCTION
DEPTH OF EXCAVATION = 3m

FIG. 2.12

HORIZONTAL
SURFACE MOVEMENT = 0.15% - HIGH STIFFNESS TOP-DOWN CONSTRUCTION

VERTICAL
SURFACE MOVEMENT AT 1.5m = 0.071% x 3m = 2.13mm
DIST. TO NEG. MOVEMENT = 6m

↳ CONSERVATIVE SINCE DEFLECTION AT TOP OF WALL SHOULD BE EXTREMELY LOW.

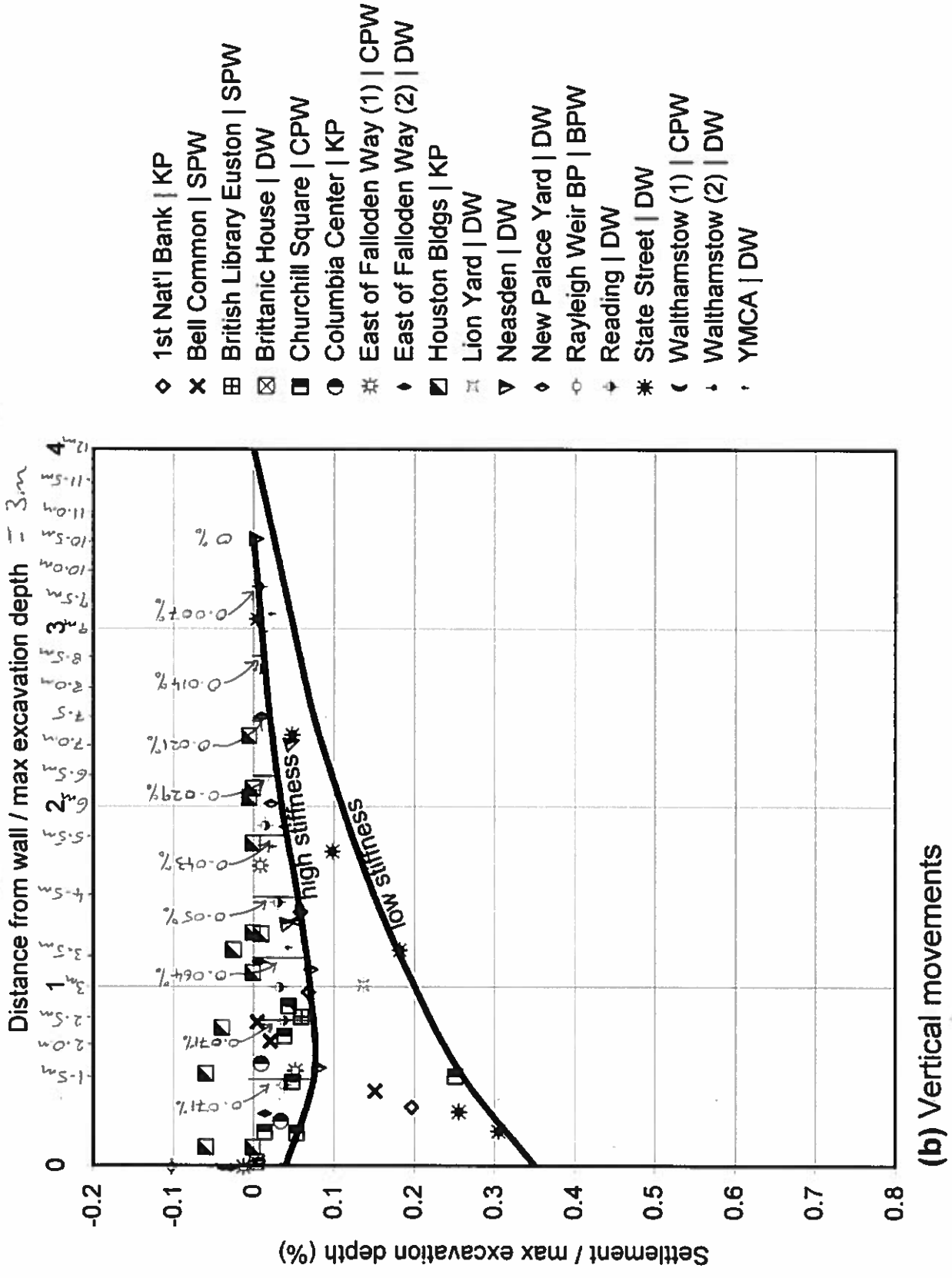
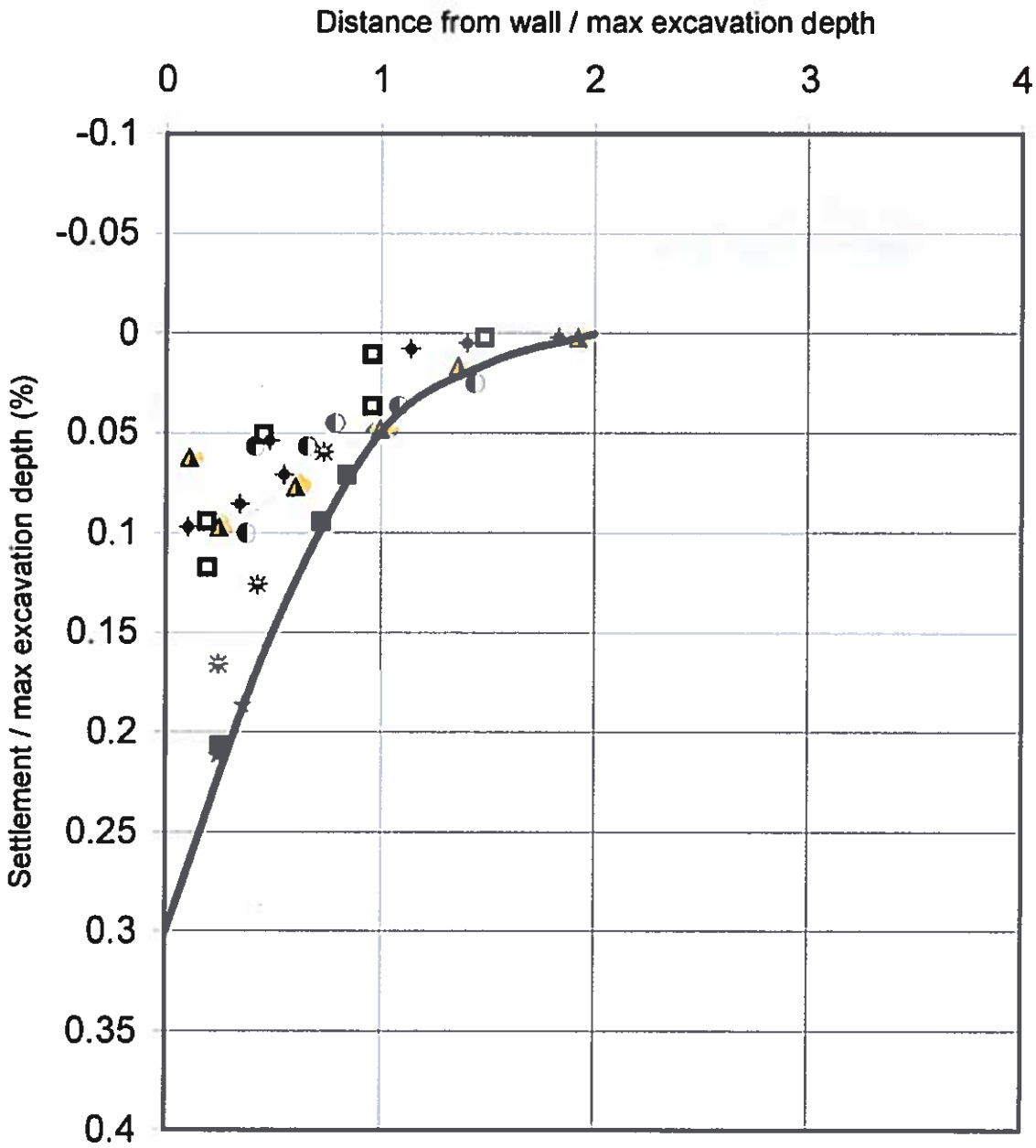


Figure 2.11 *Ground surface movements due to excavation in front of wall in stiff clay*



Key:

Site | Wall Type

SHP: Sheet pile wall — N/A
KP: King post wall — N/A
DW: Diaphragm wall

} VERY FLEXIBLE WALLS - NOT APPLICABLE

See Appendix 2 for details of case histories

~~7th & G Sts | KP~~
~~8th & G St | KP~~
~~Bergshamra | SHP~~
Chater Station | DW
~~G St Test Site | KP~~
~~Hatfield | SHP~~
~~OCC Bldg. | KP~~

EXCLUDING KING POST & SHEET PILE WALLS FROM GRAPH LEAVING ONLY DIAPHRAGM WALL DATA:

↳ REMAINING DATA CLOSELY MATCHES CURVE ON FIG. 2.11 - GROUND SURFACE SETTLEMENT DUE TO EXCAVATION IN FRONT OF WALL IN STIFF CLAY

P1 2

Figure 2.12 *Ground surface settlement due to excavation in front of wall in sand*

Ground Surface Movement due to Installation of Piles

Contiguous Piles

Depth of Piles 10 m

				At 1.5 m		At 18 m	
				Horizontal	Vertical	Horizontal	Vertical
Table 2.2	Horizontal surface movement	0.04%	4 mm				
	Distance to neg. movement	1.5	15 m				
			0.27 mm/m	3.60 mm		0 mm	
	Vertical surface movement	0.04%	4 mm				
	Distance to neg. movement	2	20 m				
			0.20 mm/m		3.70 mm		0.40 mm

Ground Surface Movement due to Excavation in front of Wall

Depth of Excavation 3 m

Table 2.4	Horizontal surface movement	0.15%	4.5 mm				
	Distance to neg. movement	4	12 m				
			0.375 mm/m	3.94 mm			
Fig. 2.12	Vertical surface movement	0.10%	3 mm				
	Distance to neg. movement	3.5	10.5 m				
			0.29 mm/m		2.57 mm		0.00 mm
				7.54 mm	6.27 mm	0.00 mm	0.40 mm

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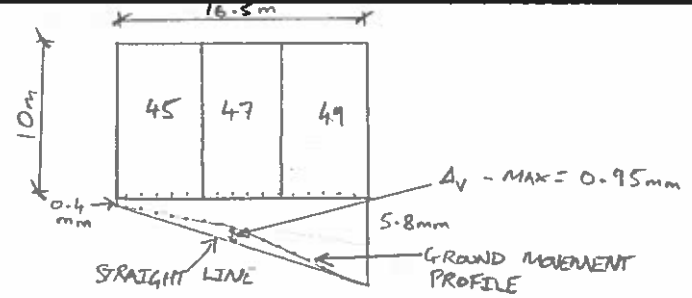
Vertical Settlements along Building

Pile Depth	10 m
Excavation Depth	3 m

Distance from Piles	Pile install movement (mm)	Distance/ excavation depth	Fig. 2.11 (%)	(mm)	Total (mm)	Straight line along Elevation	Δv (mm)	Δv/L	
0	4	0	0.050%	1.5	5.50				
1.5	3.70	0.50	0.070%	2.1	5.80	5.80	0.00	0.000%	
2.5	3.50	0.83	0.071%	2.13	5.63	5.47	0.16	0.001%	
3.5	3.30	1.17	0.064%	1.92	5.22	5.15	0.07	0.000%	
4.5	3.10	1.50	0.050%	1.5	4.60	4.82	-0.22	0.001%	
5.5	2.90	1.83	0.043%	1.29	4.19	4.49	-0.30	0.002%	
6.5	2.70	2.17	0.029%	0.87	3.57	4.16	-0.59	0.004%	
7.5	2.50	2.50	0.021%	0.63	3.13	3.84	-0.71	0.004%	
8.5	2.30	2.83	0.014%	0.42	2.72	3.51	-0.79	0.005%	
9.5	2.10	3.17	0.007%	0.21	2.31	3.18	-0.87	0.005%	
10.5	1.90	3.50	0.000%	0	1.90	2.85	-0.95	0.006%	
11.5	1.70	3.83	0.000%	0	1.70	2.53	-0.83	0.005%	
12.5	1.50	4.17	0.000%	0	1.50	2.20	-0.70	0.004%	
13.5	1.30	4.50	0.000%	0	1.30	1.87	-0.57	0.003%	
14.5	1.10	4.83	0.000%	0	1.10	1.55	-0.45	0.003%	
15.5	0.90	5.17	0.000%	0	0.90	1.22	-0.32	0.002%	
16.5	0.70	5.50	0.000%	0	0.70	0.89	-0.19	0.001%	
17.5	0.50	5.83	0.000%	0	0.50	0.56	-0.06	0.000%	
18	0.40	6.00	0.000%	0	0.40	0.40	0.00	0.000%	
18.5	0.30	6.17	0.000%	0	0.30	0.24	0.06	0.000%	
19	0.20	6.33	0.000%	0	0.20	0.07	0.13	0.001%	
20	0.00	6.67	0.000%	0	0.00	-0.25	0.25	0.002%	

Horizontal

Pile install movement (mm)	Fig. 2.11 (a) (mm)	Total (mm)	Horizontal Strain ε_H	
4	4.5	8.5		
3.60	3.94	7.54		
3.33	3.56	6.90	0.064%	
3.07	3.19	6.25	0.064%	
2.80	2.81	5.61	0.064%	
2.53	2.44	4.97	0.064%	
2.27	2.06	4.33	0.064%	B
2.00	1.69	3.69	0.064%	U
1.73	1.31	3.05	0.064%	I
1.47	0.94	2.40	0.064%	L
1.20	0.56	1.76	0.064%	D
0.93	0.19	1.12	0.064%	I
0.67	0.00	0.67	0.045%	N
0.40	0.00	0.40	0.027%	G
0.13	0.00	0.13	0.027%	
0.00	0.00	0.00	0.013%	
0.00	0.00	0.00	0.000%	
0.00	0.00	0.00	0.000%	
0.00	0.00	0.00	0.000%	
0.00	0.00	0.00	0.000%	
0.00	0.00	0.00	0.000%	
0.00	0.00	0.00	0.000%	

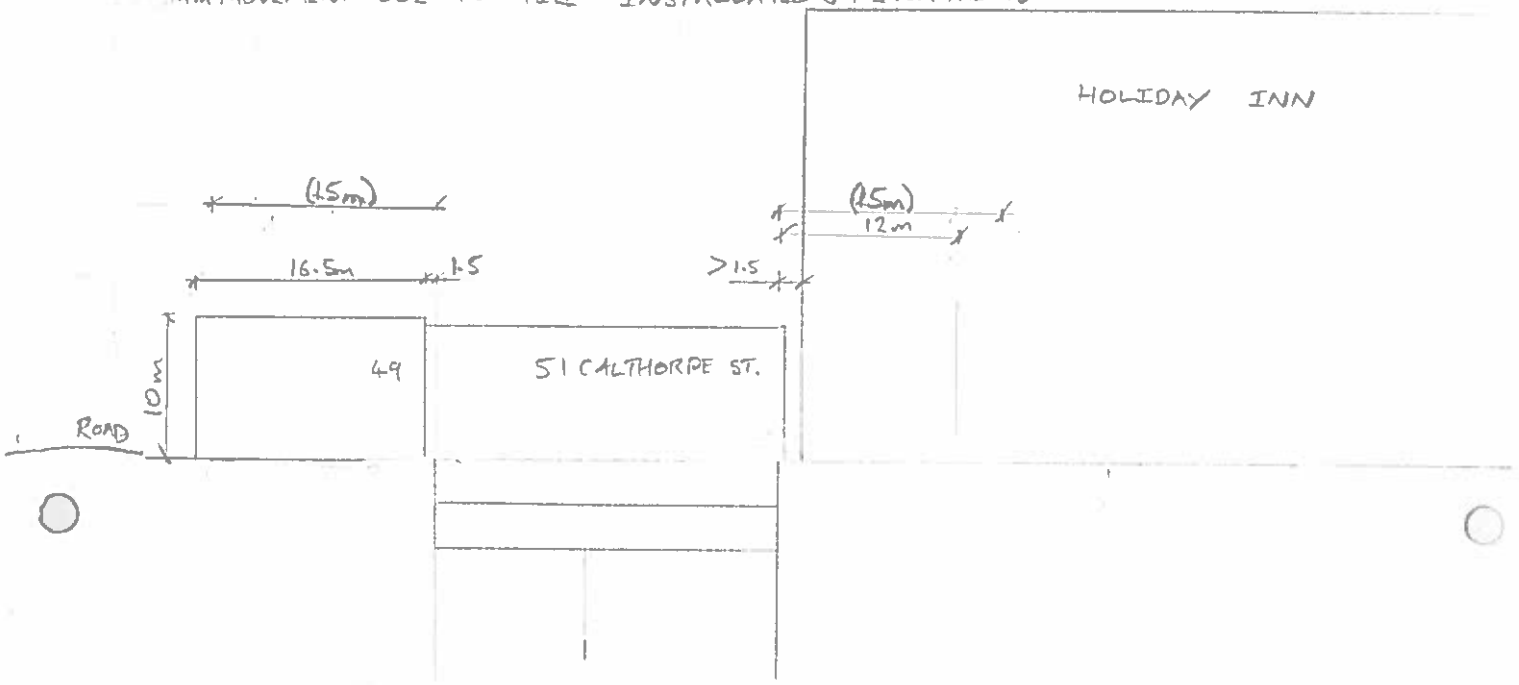


Max Δv/L	0.006%	Max ε_H	0.064%
ε_{lim}	0.075% Cat 1 Very slight	ε_{lim}	0.075% Cat 1 Very slight
Max $(\Delta v/L)/\varepsilon_{lim}$	0.077	Max $\varepsilon_H/\varepsilon_{lim}$	0.856

HORIZONTAL MOVEMENTS

AFFECTED BY CONSTRUCTION ONLY SINCE TOP-DOWN CONSTRUCTION PROVIDES RIGID PROP AT TOP OF PILES.

mm MOVEMENT DUE TO PILE INSTALLATION + EXCAVATION



TOTAL = 7.54mm @ 1.5m

AFFECTED ZONE = 15 m FROM PILES

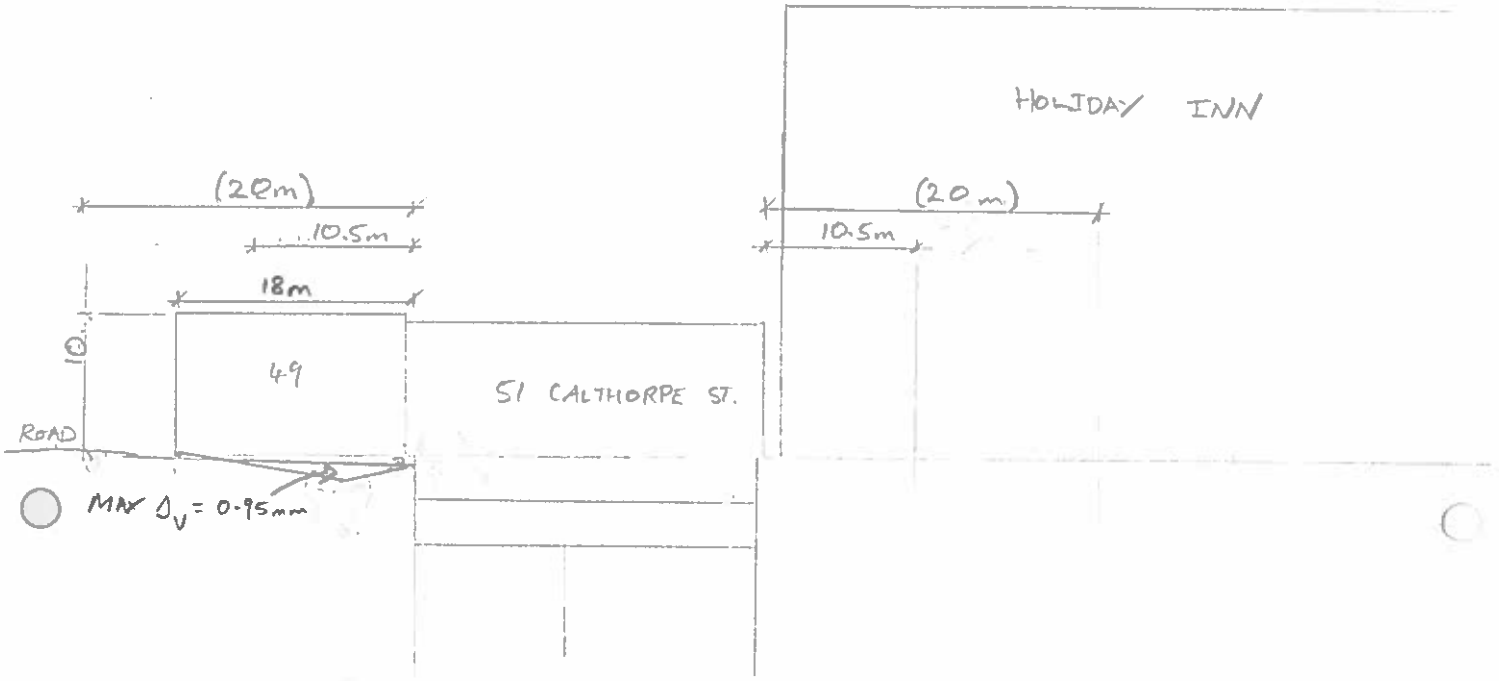
49 CALTHORPE: $\varepsilon_h = \frac{7.54mm}{(15-1.5)_m} = 0.056$ OVER 'ACTIVE' LENGTH AS WHOLE

$\varepsilon_{hmax} = 0.064$

$\varepsilon_{Lim} = 0.075$ - VERY SLIGHT (CATEGORY 1)

$$\frac{\varepsilon_h}{\varepsilon_{Lim}} = \frac{0.064}{0.075} = 0.85$$

VERTICAL MOVEMENTS



TOTAL CONSTRUCTION RELATED MOVEMENTS = 5.8mm
AFFECTED ZONE ≃ 20m
BUILDINGS > 1.5m FROM PILES:
DISPLACEMENTS AT 1.5m = 5.80mm
WORSE-CASE Δ_V = 0.95mm

Δ_v = 0.95 mm

L = 16.5m → $\frac{\Delta}{L} = \frac{0.95}{16500} = 0.006\ \%$

FOR CATEGORY 1 V. SLIGHT: $\varepsilon_{lim} = 0.075\%$

$\frac{0.006}{0.075} = 0.077$

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EXTRACT FROM CIRIA C580 – TABLE 2.5

REV. MARCH 2017

Stage 1

Ground movements behind the retaining wall should be estimated as described in Section 2.5.2 assuming greenfield conditions, ie ignoring the presence of the building or utility and the ground above foundation level. Contours of ground surface movements should be drawn and a zone of influence established based on specified settlement and distortion criteria. All structures and utilities within the zone of influence should be identified.

Stage 2

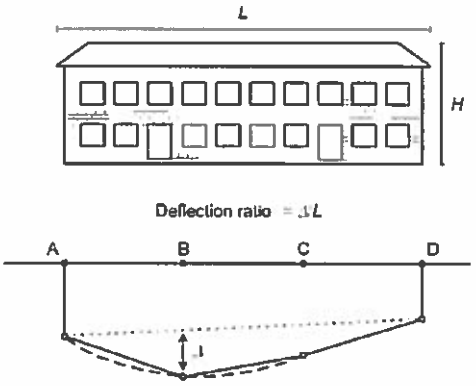
A condition survey should be carried out on all structures and utilities within the zone of influence before starting work on site. The structure or utility should be assumed to follow the ground (ie it has negligible stiffness), so the distortions and consequently the strains in the structure or utility can be calculated. The method of damage assessment should adopt the limiting tensile strain approach as described by Burland *et al* (1977), Boscardin and Cording (1989) and Burland (2001): see Table 2.5 and Figure 2.18.

Table 2.5 *Classification of visible damage to walls (after Burland* et al*, 1977, Boscardin and Cording, 1989, and Burland, 2001)*

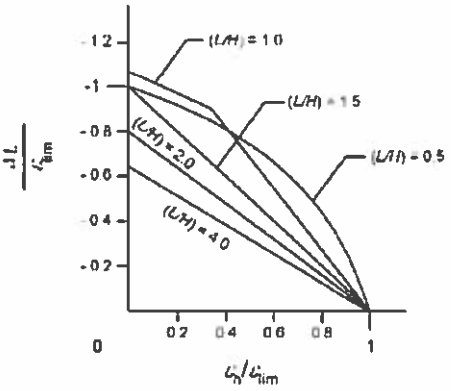
Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain ε_{lim} (per cent)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.0–0.05
1 Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection.	< 1	0.05–0.075
2 Slight	Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly.	< 5	0.075–0.15
3 Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5–15 or a number of cracks > 3	0.15–0.3
4 Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 but also depends on number of cracks	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	usually > 25 but depends on number of cracks.	

Notes

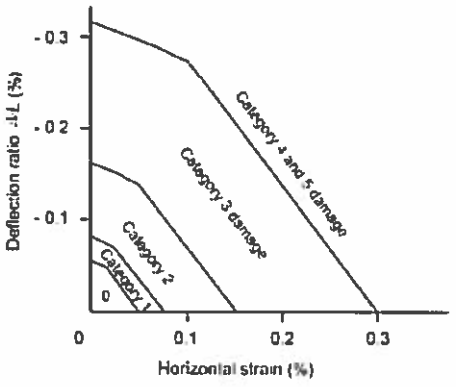
1. In assessing the degree of damage, account must be taken of its location in the building or structure.
2. Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.



(a) Definition of deflection ratio



(b) Influence of horizontal strain on Δ/L / ε_{lim} (after Burland, 2001)



(c) Relationship between damage category and deflection ratio and horizontal tensile strain for hogging for (L/H) = 1.0 (after Burland, 2001)

By adopting values of ε_{lim} associated with the various damage categories given in Table 2.5, Figure (b) can be developed into an interaction diagram showing the relationship between Δ/L and ε_h for a particular value of L/H. Figure (c) shows such a diagram for $(L/H) = 1.0$

Figure 2.18 *Relationship between damage category, deflection ratio and horizontal tensile strain (after Burland, 2001)*

Reinforced concrete-framed structures are more flexible in shear than are masonry structures and are consequently less susceptible to damage. Nevertheless, for the purposes of a stage 2 assessment of potential damage, all structures should be treated as masonry structures.

Box 2.5 *Procedure for stage 2 damage category assessment*

The following steps should be undertaken in making a stage 2 assessment of the damage to a structure:

(i) establish L and H for the structure (see Figure 2.18(a) for definitions of L and H)

(ii) determine (L/H)

(iii) determine relationship between (Δ/L) and ε_h for the required (L/H) from Figure 2.18(b) for ε_{lim} values from Table 2.5

(iv) estimate vertical and horizontal ground surface movements in the vicinity of the structure from Figure 2.14

(v) determine (Δ/L) and ε_h $(= \delta_h/L)$ where δ_h is the horizontal movement

(vi) estimate damage category from the relationship between (Δ/L) and ε_h established from step (iii) above.

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FRONT & REAR ELEVATIONS

$$\frac{L}{H} = \frac{16.5}{10} = 1.65$$

INTERPOLATING LINES : POINT ON $\frac{\Delta}{L}/\varepsilon_{lim}$ @ $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0 = 0.94$

$\therefore$ LINE = $0.94 - 0.94 \times \frac{\varepsilon_h}{\varepsilon_{lim}}$

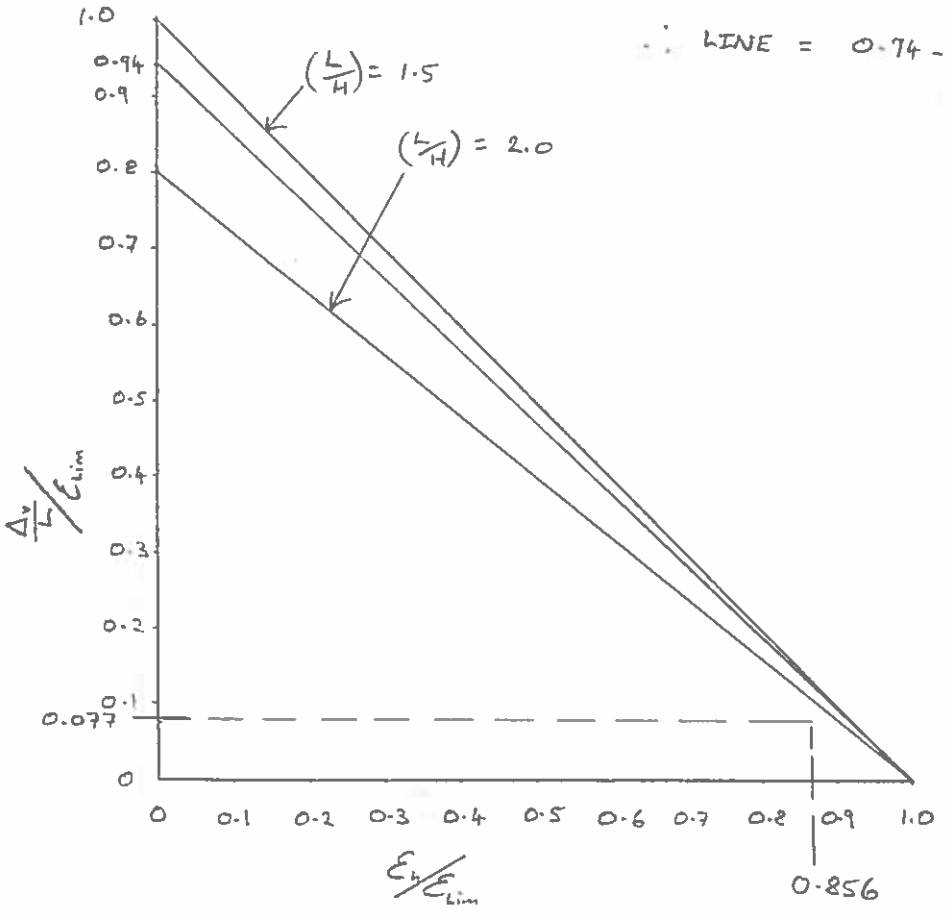

FIG. 2.18(b)

$$\frac{\Delta}{L}/\varepsilon_{lim} = 0.077$$

$$\frac{\varepsilon_h}{\varepsilon_{lim}} = 0.856$$

CHECK COMBINED STRAINS ARE UNDER LINE:

MAX. $\frac{\Delta}{L}/\varepsilon_{lim} = 0.94 - 0.94 \times 0.856 = 0.135$

ACTUAL = 0.077 $\therefore$ O.K.

$\therefore$ **CATEGORY 1 - VERY SLIGHT**

CALCULATION SHEET

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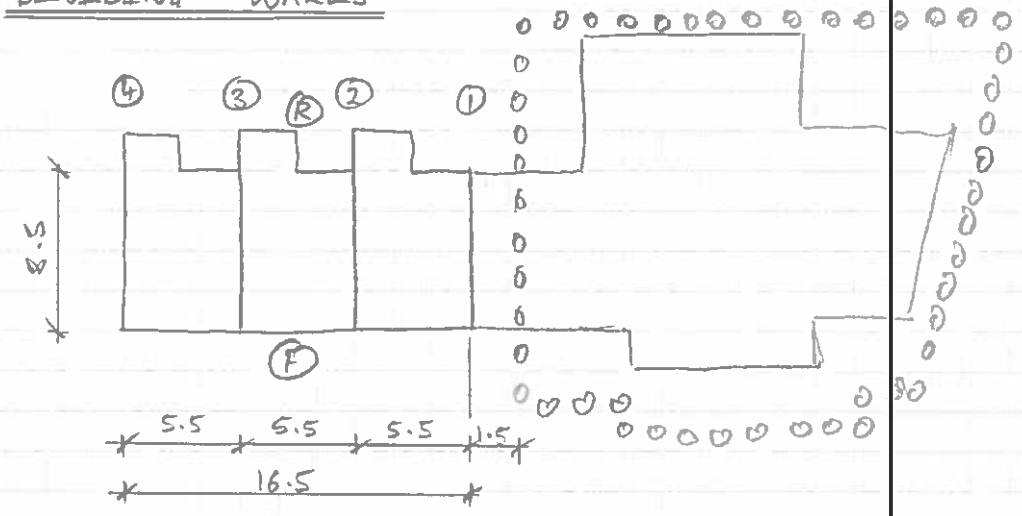
Project: 51 CALTHORPE STREET	Sheet no. of	Job No:
	Calc. no: P/15a	Checked by:
Subject: 49 CALTHORPE ST- DIV. WALL CHECK	Made by: PMO	Date:
	Date: 28/03/2017	

DIVIDING WALLS



WALL ON ①

DIST. FROM PILES = 1.5m

L = 8.5m

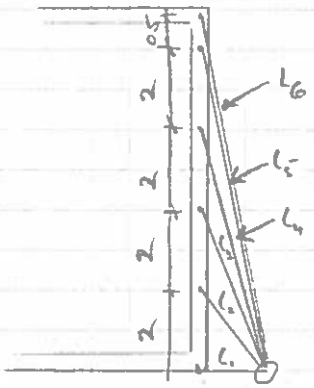
H = 10m

$\rightarrow \frac{L}{H} = 0.85$

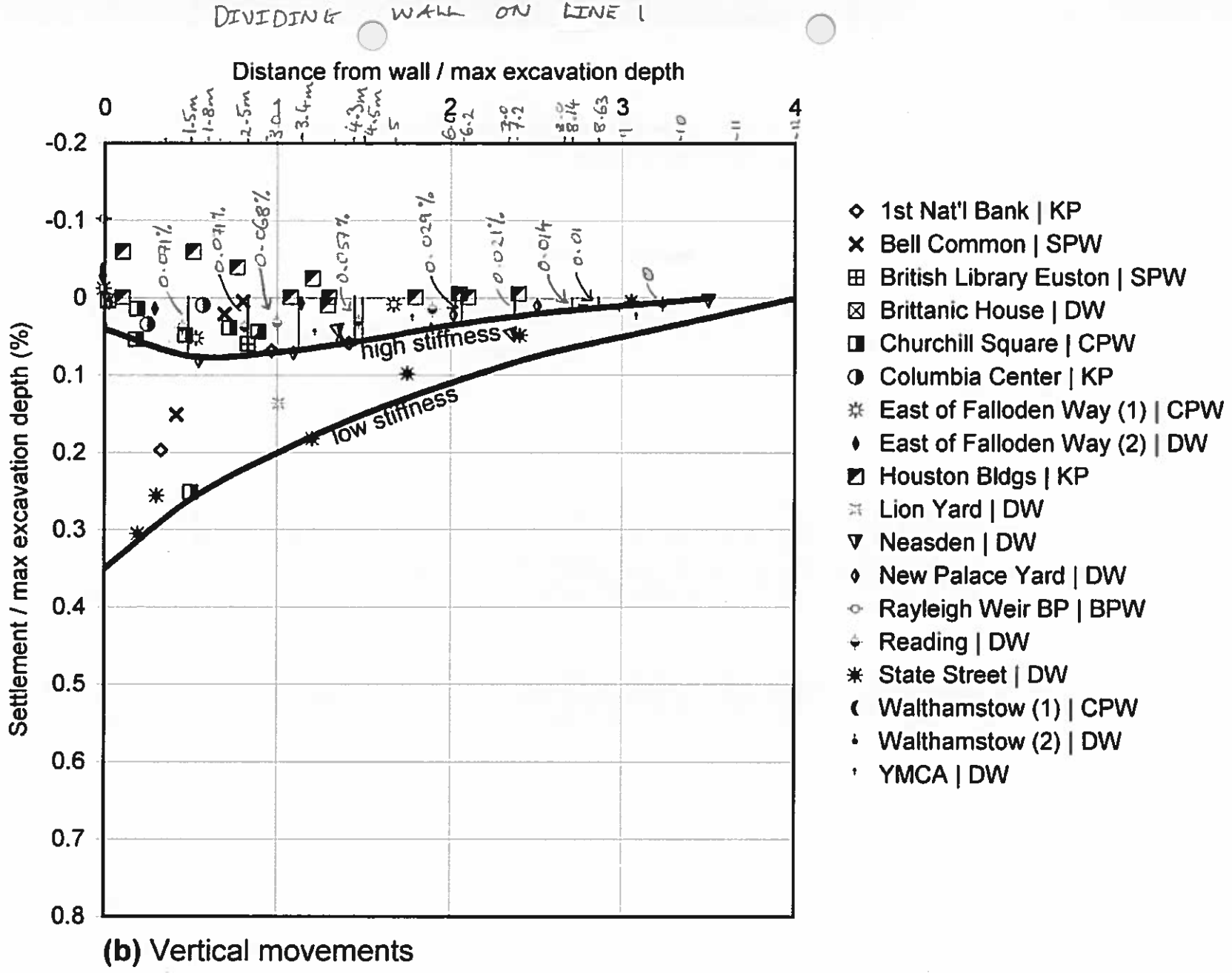
GEN. MOVEMENT CONSISTENT ALONG WALL EXPECTED. FOR CONSERVATISM CHECK CASES WITH LOCALISED SETTLEMENT ONLY:

CASE 1

MOVEMENT TO GROUND AT FRONT (Ⓕ) END ONLY, NEG. MOVEMENT AT Ⓡ:



		DIST / MAX. EXCAVATION DEPTH
L_1 =	1.5m	0.5
L_2 =	2.5m	0.83
L_3 =	4.3m	1.43
L_4 =	6.2m	2.1
L_5 =	8.14m	2.71
L_6 =	8.63m	2.88



(b) Vertical movements

Figure 2.11 *Ground surface movements due to excavation in front of wall in stiff clay*

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49 Calthorpe Street Ground Movement Assessment

Vertical Settlements Dividing Wall - Case 1

Pile Depth	10 m
Excavation Depth	3 m

Distance from Piles	Pile install movement (mm)	Distance/ excavation depth	Fig. 2.11 (%)	(mm)	Total (mm)	Straight line along Elevation	Δv (mm)	Δv/L	Pile install movement (mm)	Fig. 2.11 (a) (mm)	Total (mm)	Horizontal Strain ε_H	
									Horizontal				
0	4	0	0.050%	1.5	5.50				4	4.5	8.5		
1.5	3.70	0.50	0.070%	2.1	5.80	5.80	0.00	0.000%	3.60	3.94	7.54		B
2.5	3.50	0.83	0.071%	2.13	5.63	5.35	0.28	0.003%	3.33	3.56	6.90	0.064%	U
3	3.40	1.00	0.068%	2.04	5.44	5.12	0.32	0.004%	3.20	3.38	6.58	0.064%	I
4.3	3.14	1.43	0.057%	1.71	4.85	4.53	0.32	0.004%	2.85	2.89	5.74	0.064%	L
6.2	2.76	2.07	0.029%	0.87	3.63	3.67	-0.04	0.001%	2.35	2.18	4.52	0.064%	D
7.2	2.56	2.40	0.021%	0.63	3.19	3.22	-0.03	0.000%	2.08	1.80	3.88	0.064%	I
8.14	2.37	2.71	0.014%	0.42	2.79	2.80	0.00	0.000%	1.83	1.45	3.28	0.064%	N
8.63	2.27	2.88	0.010%	0.3	2.57	2.57	0.00	0.000%	1.70	1.26	2.96	0.064%	G
10	2.00	3.33	0.007%	0.21	2.21				1.33	0.75	2.08		
11	1.80	3.67	0.000%	0	1.80				1.07	0.38	1.44		
12	1.60	4.00	0.000%	0	1.60				0.80	0.00	0.80		
13	1.40	4.33	0.000%	0	1.40				0.53	0.00	0.53		
14	1.20	4.67	0.000%	0	1.20				0.27	0.00	0.27		
15	1.00	5.00	0.000%	0	1.00				0.00	0.00	0.00		
16	0.80	5.33	0.000%	0	0.80				0.00	0.00	0.00		
17	0.60	5.67	0.000%	0	0.60				0.00	0.00	0.00		
18	0.40	6.00	0.000%	0	0.40				0.00	0.00	0.00		
18.4	0.32	6.13	0.000%	0	0.32				0.00	0.00	0.00		
18.5	0.30	6.17	0.000%	0	0.30				0.00	0.00	0.00		
19	0.20	6.33	0.000%	0	0.20				0.00	0.00	0.00		
20	0.00	6.67	0.000%	0	0.00				0.00	0.00	0.00		

Max Δv/L	0.004%	Max ε_H	0.064%
ε_{lim}	0.075% Cat 1 Very slight	ε_{lim}	0.075% Cat 1 Very slight
Max $(\Delta v/L)/\varepsilon_{lim}$	0.050	Max $\varepsilon_H/\varepsilon_{lim}$	0.856

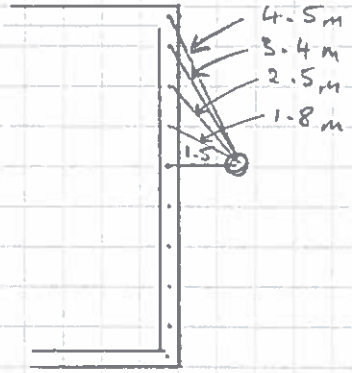
CALCULATION SHEET

create CONSULTING ENGINEERS LTD

Project: 51 CALTHORPE STREET	Sheet no. of	Job No:
	Calc. no: A/17	Checked by:
Subject: 49 CALTHORPE ST – DIV. WALL CHECK	Made by: PMO	Date:
	Date: 28/03/2018	

CASE 2

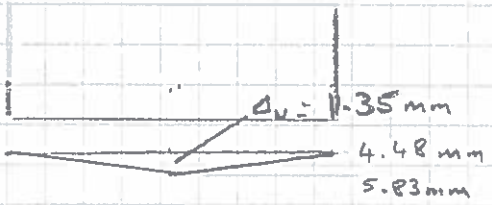
CENTRAL DEFLECTION, NO MOVEMENT AT ENDS



MOVEMENT DUE TO EXCAVATION:

$L_1 = 1.5 = 0.071\ \%$
$L_2 = 1.8 = 0.078$
$L_3 = 2.5 = 0.071$
$L_4 = 3.4 = 0.064$
$L_5 = 4.5 = 0.05$
$L_6 = 1.8 = 0.078$
$L_7 = 2.5 = 0.071$
$L_8 = 3.4 = 0.064$
$L_9 = 4.5 = 0.05$

VERTICAL MOVEMENTS



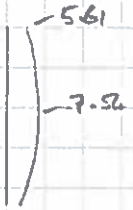
$$\frac{\Delta_V}{L} = \frac{1.35}{8500} = 0.016\ \%$$

FOR CATEGORY 1: $\frac{0.016}{0.075} = 0.21$

HORIZONTAL MOVEMENTS

MOVEMENT IS OUT-OF-PLANE

MAX. $\Delta_H = 7.54mm - 5.61mm$



$\Delta_H = 1.93mm$

$$\varepsilon_H = \frac{1.93}{8500} = 0.023\ \%$$

$$\frac{\varepsilon_H}{\varepsilon_{lim}} = \frac{0.023}{0.075} = 0.3$$

Vertical Settlements Dividing Wall - Case 2									Horizontal				
Pile Depth		10 m											
Excavation Depth		3 m											
Distance from Piles	Pile install movement (mm)	Distance/ excavation depth	Fig. 2.11 (%)	(mm)	Total (mm)	Straight line along Elevation	Δv (mm)	Δv/L	Pile install movement (mm)	Fig. 2.11 (a) (mm)	Total (mm)	Horizontal Strain ε_H	
0	4	0	0.050%	1.5	5.50				4	4.5	8.5		
1.5	3.70	0.50	0.071%	2.13	5.83	5.83	0.00		3.60	3.94	7.54		BUILDING
1.8	3.64	0.60	0.078%	2.34	5.98	5.69	0.29		3.52	3.83	7.35		
2.5	3.50	0.83	0.071%	2.13	5.63	5.38	0.25		3.33	3.56	6.90		
3.4	3.32	1.13	0.064%	1.92	5.24	4.97	0.27		3.09	3.23	6.32		
4.5	3.10	1.50	0.050%	1.5	4.60	4.48	0.12		2.80	2.81	5.61		
5	3.00	1.67	0.040%	1.2	4.20				2.67	2.63	5.29		
6	2.80	2.00	0.035%	1.05	3.85				2.40	2.25	4.65		
7	2.60	2.33	0.025%	0.75	3.35				2.13	1.88	4.01		
8	2.40	2.67	0.140%	4.2	6.60				1.87	1.50	3.37		
9	2.20	3.00	0.010%	0.3	2.50				1.60	1.13	2.73		
10	2.00	3.33	0.000%	0	2.00				1.33	0.75	2.08		
11	1.80	3.67	0.000%	0	1.80				1.07	0.38	1.44		
12	1.60	4.00	0.000%	0	1.60				0.80	0.00	0.80		
13	1.40	4.33	0.000%	0	1.40				0.53	0.00	0.53		
14	1.20	4.67	0.000%	0	1.20				0.27	0.00	0.27		
15	1.00	5.00	0.000%	0	1.00				0.00	0.00	0.00		
16	0.80	5.33	0.000%	0	0.80				0.00	0.00	0.00		
18.4	0.32	6.13	0.000%	0	0.32				0.00	0.00	0.00		
18.5	0.30	6.17	0.000%	0	0.30				0.00	0.00	0.00		
19	0.20	6.33	0.000%	0	0.20				0.00	0.00	0.00		
20	0.00	6.67	0.000%	0	0.00				0.00	0.00	0.00		

CALCULATION SHEET

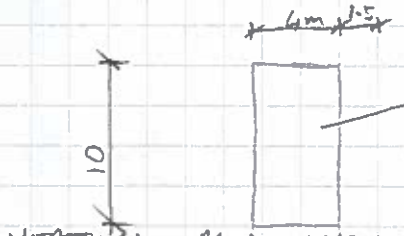
create CONSULTING ENGINEERS LTD

Project: 51 CALTHORPE ST.	Sheet no. of	Job No:
	Calc. no: P/186	Checked by:
Subject: 49 CALTHORPE ST - SPINE WALL	Made by: PMO	Date:
	Date: 29/03/2017	

INTERNAL SPINE WALLS

WALLS PERP. TO DIVIDING WALL.
LENGTH ~ 4m

WALL A



ELEVATION OF WALL

$\frac{L}{H} = \frac{4}{10} = 0.4$

VERTICAL MOVEMENTS:

Δ_V MAX = 0.23 mm

$\frac{0.23}{4000} = 0.006\%$

HORIZONTAL MOVEMENTS

MAX. ε_H = 0.064 %

REFERING TO PAGE P/19 GRAPH:

$\frac{\varepsilon_H}{\varepsilon_{lim}} = \frac{0.064}{0.075} = 0.856$

$\frac{\Delta_L}{\varepsilon_{lim}} = \frac{0.006}{0.075} = 0.08$

51 Calthorpe St. BIA

49 Calthorpe Street Ground Movement Assessment

Vertical Settlements along Spine Walls									Horizontal				
Pile Depth			10 m										
Excavation Depth			3 m										
Distance from Piles	Pile install movement (mm)	Distance/ excavation depth	Fig. 2.11 (%)	(mm)	Total (mm)	Straight line along Elevation	Δv (mm)	Δv/L	Pile install movement (mm)	Fig. 2.11 (a) (mm)	Total (mm)	Horizontal Strain ε_H	
0	4	0	0.050%	1.5	5.50				4	4.5	8.5		
1.5	3.70	0.50	0.070%	2.1	5.80	5.80	0.00	0.000%	3.60	3.94	7.54		W
2.5	3.50	0.83	0.071%	2.13	5.63	5.40	0.23	0.006%	3.33	3.56	6.90	0.064%	A
3.5	3.30	1.17	0.064%	1.92	5.22	5.00	0.23	0.006%	3.07	3.19	6.25	0.064%	L
4.5	3.10	1.50	0.050%	1.5	4.60	4.59	0.01	0.000%	2.80	2.81	5.61	0.064%	L
5.5	2.90	1.83	0.043%	1.29	4.19	4.19	0.00	0.000%	2.53	2.44	4.97	0.064%	A
6.5	2.70	2.17	0.029%	0.87	3.57	4.16			2.27	2.06	4.33		
7	2.60	2.33	0.025%	0.75	3.35	3.35	0.00	0.000%	2.13	1.88	4.01		W
8	2.40	2.67	0.014%	0.42	2.82	2.96	-0.14	0.004%	1.87	1.50	3.37	0.064%	A
9	2.20	3.00	0.007%	0.21	2.41	2.58	-0.17	0.004%	1.60	1.13	2.73	0.064%	L
10	2.00	3.33	0.000%	0	2.00	2.19	-0.19	0.005%	1.33	0.75	2.08	0.064%	L
11	1.80	3.67	0.000%	0	1.80	1.80	0.00	0.000%	1.07	0.38	1.44	0.064%	B
12	1.60	4.00	0.000%	0	1.60	2.36			0.80	0.00	0.80		
12.5	1.50	4.17	0.000%	0	1.50	1.50	0.00	0.000%	0.67	0.00	0.67		W
13.5	1.30	4.50	0.000%	0	1.30	1.30	0.00	0.000%	0.40	0.00	0.40	0.027%	A
14.5	1.10	4.83	0.000%	0	1.10	1.10	0.00	0.000%	0.13	0.00	0.13	0.027%	L
15.5	0.90	5.17	0.000%	0	0.90	0.90	0.00	0.000%	0.00	0.00	0.00	0.013%	L
16.5	0.70	5.50	0.000%	0	0.70	0.70	0.00	0.000%	0.00	0.00	0.00	0.000%	C
18	0.40	6.00	0.000%	0	0.40				0.00	0.00	0.00		
18.5	0.30	6.17	0.000%	0	0.30				0.00	0.00	0.00		
19	0.20	6.33	0.000%	0	0.20				0.00	0.00	0.00		
20	0.00	6.67	0.000%	0	0.00				0.00	0.00	0.00		

WALL A
= WORSE CASE

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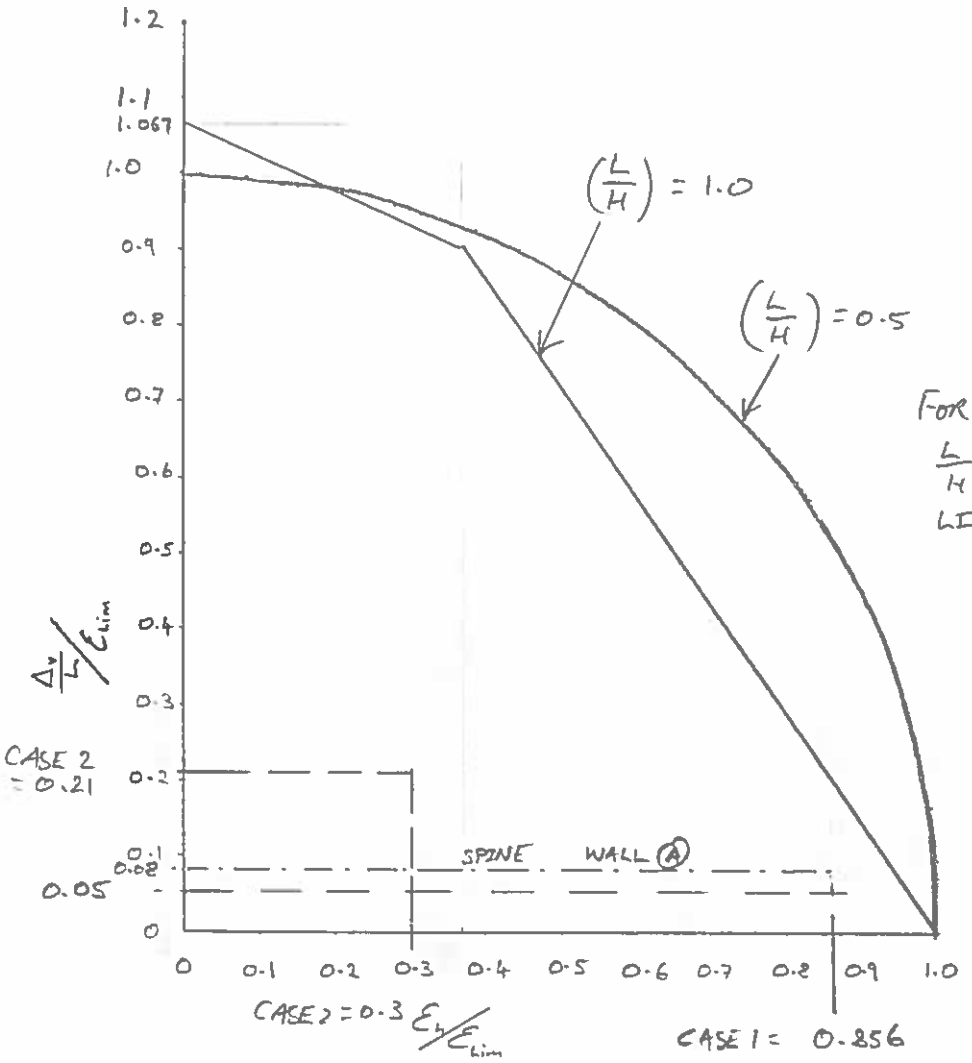
49 CALTHORPE ST.
DIVIDING WALL



FOR SPINE WALLS,
$\frac{L}{H}$ = 0.4 - USE
LINE = 0.5 - CONSERVATIVE

FIG. 2.18(b)

DIVIDING WALL:

CASE 1: $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0.856$ $\qquad \frac{\frac{\Delta}{L}}{\varepsilon_{lim}} = 0.05$

$\therefore$ O.K. - CAT. 1 VERY SLIGHT

CASE 2: $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0.3$ $\qquad \frac{\frac{\Delta}{L}}{\varepsilon_{lim}} = 0.21$

$\therefore$ O.K - CAT. 1 VERY SLIGHT

SPINE WALL A: $\frac{\varepsilon_h}{\varepsilon_{lim}} = 0.856$, $\frac{\Delta}{L}/\varepsilon_{lim} = 0.08$ $\rightarrow$ O.K. CAT 1.

$\therefore$ DIVIDING WALLS ALL WITHIN CATEGORY 1 - VERY SLIGHT

SPINE WALLS ALL WITHIN CATEGORY 1 - VERY SLIGHT

CALCULATION SHEET

create CONSULTING ENGINEERS LTD

Project: 51 CALTHORPE ST BIA	Sheet no. of	Job No: P12-385
	Calc. no: P/20	Checked by:
Subject: CLASSIFICATION OF VISIBLE DAMAGE CHECKS MIXED USE SCHEME	Made by: REV. MARCH 2017 AMO Date: 9/9/16	Date:

CHECK ON HOLIDAY INN

HOLIDAY INN HAS A BASEMENT OF SIMILAR SIZE / DEPTH TO THAT PROPOSED AT 51 CALTHORPE ST.
∴ NO GROUND MOVEMENT DUE TO EXCAVATION WOULD BE EXPECTED.

3.60 mm HORIZONTAL

3.73 mm VERTICAL

DAMAGE CATEGORY

LENGTH OF BUILDING = 52 m

TAKING STRAIN ONLY OVER : 15 m HORIZ.
20 m VERT.

$\frac{L}{H} = \frac{52}{30} = 1.73$

HORIZONTAL STRAINS :

$\varepsilon_h : \frac{3.6}{15000} = 0.024\%$

FOR V. SLIGHT CATEGORY : $\frac{0.024}{0.075} = 0.32$

FOR NEG. : $\frac{0.024}{0.05} = 0.48$

VERTICAL

$\frac{3.7}{20\,m} = 0.019\%$

FOR V. SLIGHT : $\frac{0.019}{0.075} = 0.25$

NEG. $\frac{0.019}{0.05} = 0.38$

SEE PREVIOUS = NEGLIGIBLE CATEGORY

Ground Surface Movement due to Installation of Piles

Contiguous Piles
Depth of Piles 10 m

				At 1.5 m		At 52 m	
				Horizontal	Vertical	Horizontal	Vertical
Table 2.2	Horizontal surface movement	0.04%	4 mm				
	Distance to neg. movement	1.5	15 m				
			0.27 mm/m	3.60 mm		0 mm	
	Vertical surface movement	0.04%	4 mm				
	Distance to neg. movement	2	20 m				
			0.20 mm/m		3.70 mm		0.00 mm

Ground Surface Movement due to Excavation in front of Wall

Depth of Excavation 3 m

Table 2.4	Horizontal surface movement	0.00%	0 mm				
	Distance to neg. movement	4	12 m				
			0.00 mm/m	0.00 mm			
Fig. 2.12	Vertical surface movement	0.00%	0 mm				
	Distance to neg. movement	3.5	10.5 m				
			0.00 mm/m		0.00 mm		0.00 mm
				3.60 mm	3.70 mm	0.00 mm	0.00 mm

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HOLIDAY INN

$$L/H = \frac{51}{30} = 1.73$$

INTERPOLATING LINES : POINT ON $\frac{\Delta}{L}/\varepsilon_{Lim} = 0 = 0.85$

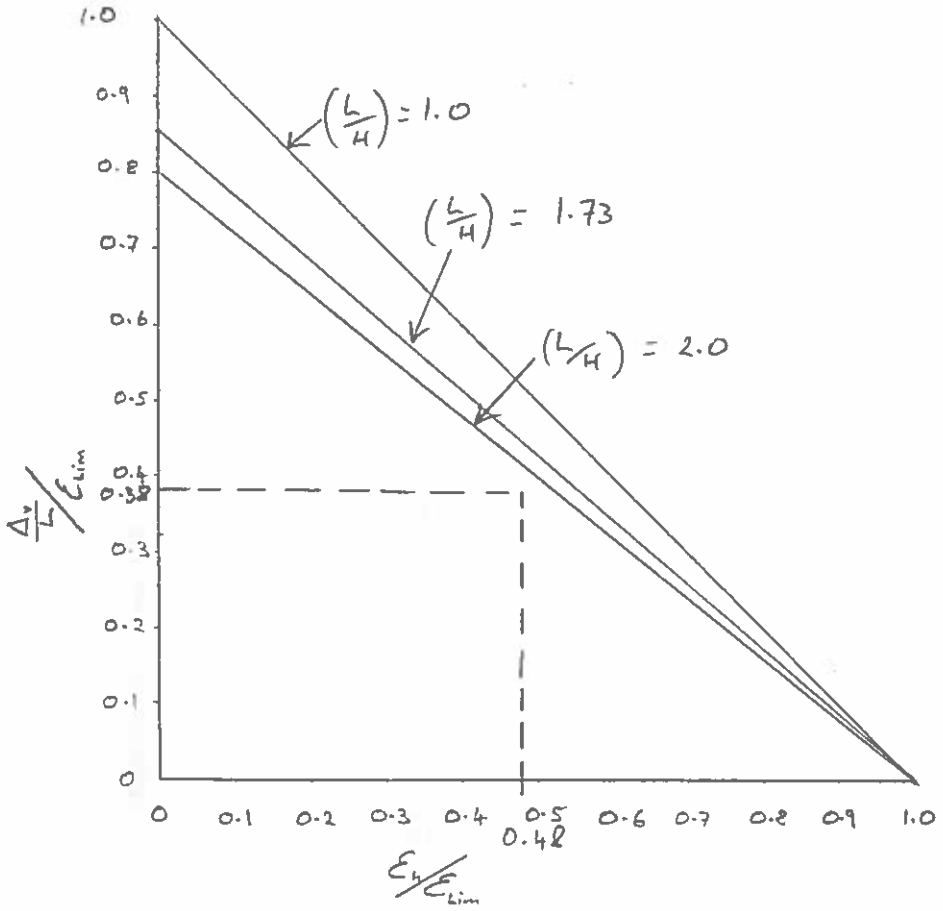


FIG. 2.18(b)

$$\frac{\Delta}{L}/\varepsilon_{Lim} = 0.38$$

$$\frac{\varepsilon_h}{\varepsilon_{Lim}} = 0.48$$

CHECK COMBINED STRAINS ARE UNDER LINE :

MAX. $\frac{\Delta}{L}/\varepsilon_{Lim} = 0.85 - 0.85 \times 0.32 = 0.578$

ACTUAL = $\therefore$ O.K.

$\therefore$ **CATEGORY 0 - NEGLIGIBLE**

CALCULATION SHEET

create CONSULTING ENGINEERS LTD

Project: 51 CALTHORPE ST BIA	Sheet no. of	Job No:
	Calc. no: P123	Checked by:
Subject: CLASSIFICATION OF VISIBLE DAMAGE ASSESSMENT	Made by: RMO REV. MARCH 2017	Date:
	Date: 09/09/16	

EFFECTS ON ROAD

MIN DISTANCE TO ROAD = AT S/E CORNER
= ~5m

AT 5m FROM PILES, VERT. MOVEMENTS ≈ 0.02 %
= 0.6mm

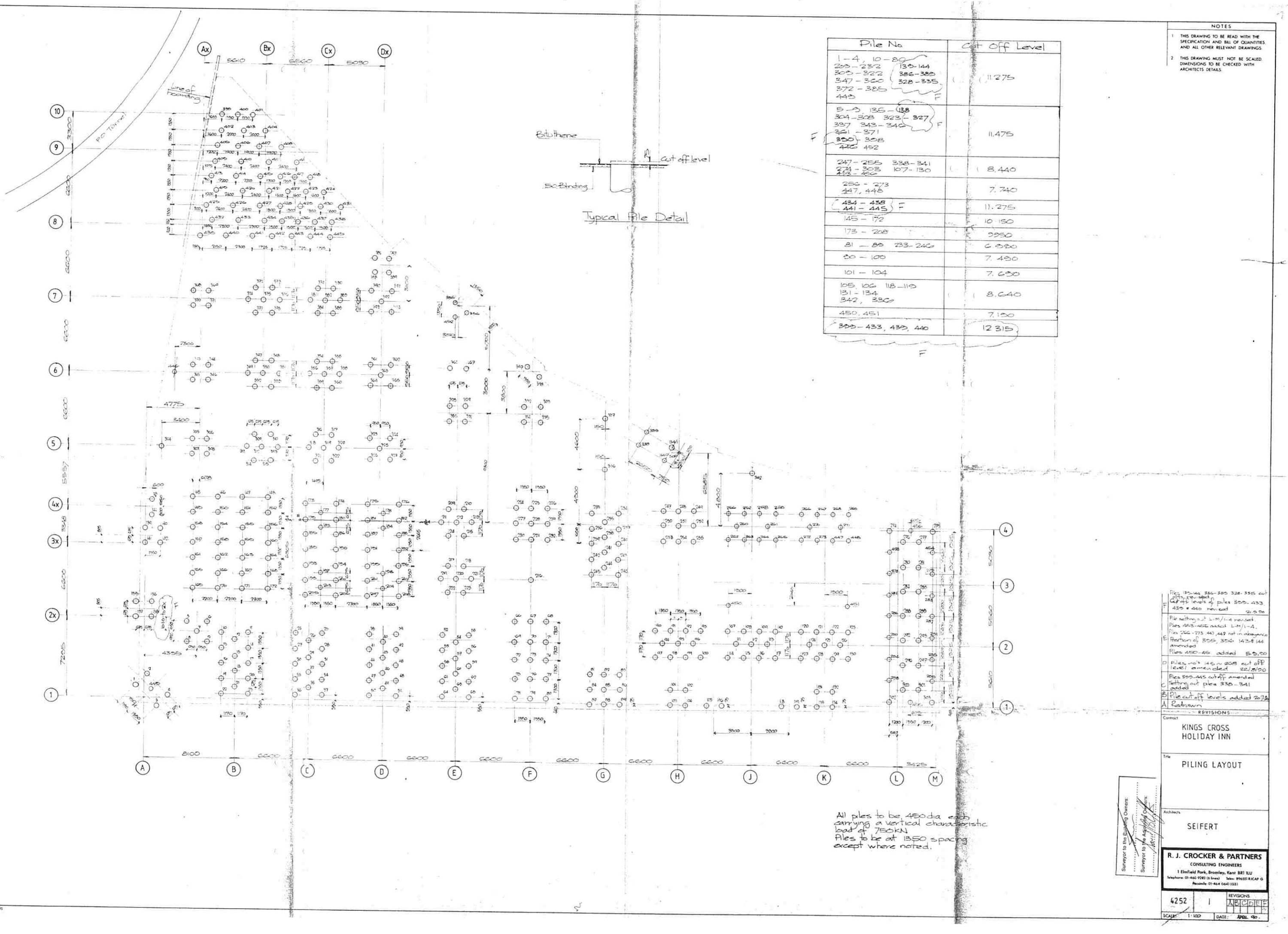
HORIZONTAL = 2.67 mm + 0.88 = 3.54mm

VERTICAL = 3.00mm + 0.6mm = 3.6mm

CARRIAGEWAY IS AT GRADE. THIS SORT OF MOVEMENT (MAX.) WOULD ONLY GENERATE VERY LOW STRAINS, WELL WITHIN WHAT CAN BE TOLERATED BY A HIGHWAY.

∴ NEGLIGIBLE EXPECTED EFFECT ON ROAD

APPENDIX Q



Typical Pile Detail

Pile No.	Cut Off Level
1 – 4, 10 – 80, 265 – 282, 303 – 322, 347 – 360, 372 – 385, 445 (135–144, 386–388, 328–335) F	11.275
5 – 9, 135 – 138, 304 – 308, 323 – 327, 337, 343 – 346, 361 – 371, 389 – 398, 446 – 452 F	11.475
247 – 255, 338 – 341, 274 – 303, 107 – 130, 453 – 456	8.440
256 – 273, 447, 448	7.740
434 – 438, 441 – 445 F	11.275
145 – 172	10.150
173 – 208	9.950
81 – 88, 233 – 246	6.890
90 – 100	7.490
101 – 104	7.690
105, 106, 118 – 119, 131 – 134, 342, 336	8.640
450, 451	7.150
399 – 433, 439, 440	12.315

F

NOTES

1 THIS DRAWING TO BE READ WITH THE SPECIFICATION AND BILL OF QUANTITIES AND ALL OTHER RELEVANT DRAWINGS.

2 THIS DRAWING MUST NOT BE SCALED. DIMENSIONS TO BE CHECKED WITH ARCHITECTS DETAILS.

All piles to be 450 dia each carrying a vertical characteristic load of 750KN
Piles to be at 1350 spacing except where noted.

Surveyor to this Building Owners:

Surveyor to the Adjoining Owners:

F	Piles 135-144, 386-388, 328-335 cut off level amended Cut off levels of piles 399-433, 439 & 440 revised 2.5.90
E	Pile setting out L-M/1-4 revised. Piles 453-456 added L-M/1-4. Piles 256-273, 447, 449 not in sequence. Position of 399, 336, 143 & 144 amended. Piles 450-452 added 5.5.90
D	Piles no's 145 to 208 cut off level amended 22.3.90
C	Piles 399-445 cut off amended Setting out piles 336-341 added
B	Pile cut off levels added 20.2.90
A	Redrawn

REVISIONS

Contract: KINGS CROSS HOLIDAY INN

Title: PILING LAYOUT

Architects: SEIFERT

R. J. CROCKER & PARTNERS
CONSULTING ENGINEERS
1 Elmfield Park, Bromley, Kent BR1 1LU
Telephone: 01-460 9292 (5 lines) Telex: 896551 RJCAP G
Facsimile: 01-464 0643 (G3)

4252 | 1 | REVISIONS A B C D E F

SCALE: 1:100 | DATE: APRIL 90.

GEOPRINT 1695