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**51 CALTHORPE STREET, LONDON, WC1X 0HH**  
**Basement Impact Assessment – Revision C Version 4 – Volume 5 of 5**

## **APPENDIX P**



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

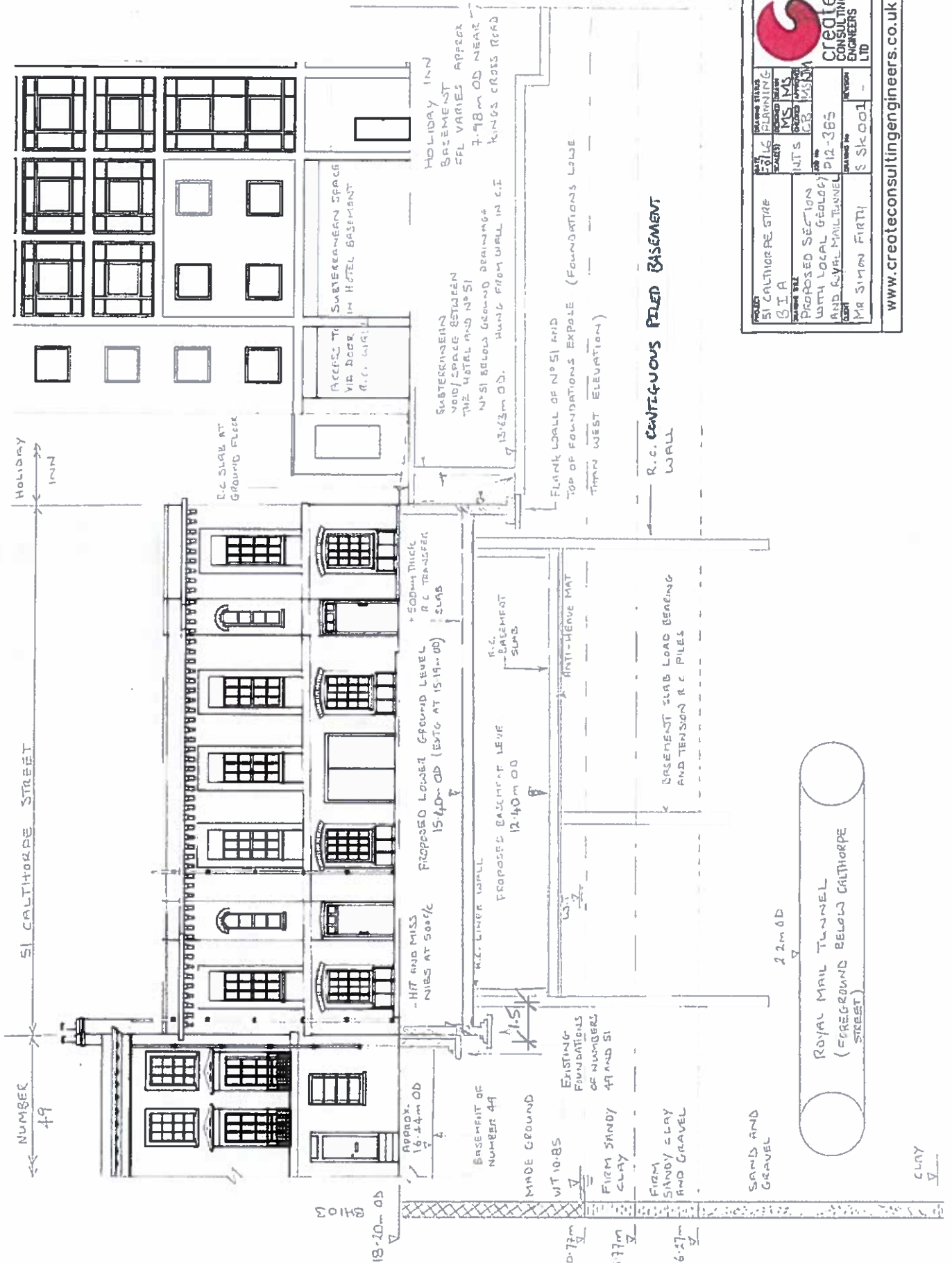
**Ground Movement Calculations for Proposed Basement at 51 Calthorpe Street**

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 ST BIA	PLANNING	MS MS	DATE	12/12/16
CLIENT	MR SIMON FIRTH	DESIGNED BY	MS MS	DATE	12/12/16
NO	12-365	CHECKED BY	MS MS	DATE	12/12/16
DESCRIPTION	PROPOSED SECTION WITH LOCAL GEOLOGY AND R.C. MAIL TUNNEL	SCALE	1:50	DATE	12/12/16
PROJECT NO	8 SK 001	DATE	12/12/16	SCALE	1:50

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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  $(\Delta/L)$  and  $\epsilon_h$  for the required  $(L/H)$  from Figure 2.18(b) for  $\epsilon_{lim}$  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  $(\Delta/L)$  and  $\epsilon_h (= \delta_h/L)$  where  $\delta_h$  is the horizontal movement
- (vi) estimate damage category from the relationship between  $(\Delta/L)$  and  $\epsilon_h$  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.

Project: 51 Calthorpe Street BIA	Sheet no. of	Job No: P12-385
	Calc. no: P14	Checked by:
Subject: CLASSIFICATION OF VISIBLE DAMAGE ASSESSMENT	Made by:	Date:
	PMO REV. MARCH 17 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)
<b>Bored piles</b>				
Contiguous	0.04	1.5	0.04	2
Secant	0.08	1.5	0.05	2
<b>Diaphragm walls</b>				
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 - CONSERVA-TIVE	3.5	0.35	4

-ALSO SEE FIG. 2.12 - MOVEMENTS IN SAND



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

HORIZONTAL MOVEMENT - CIRIA C580  
EMBEDDED RETAINING WALLS -

GROUND SURFACE MOVEMENT DUE TO EMBEDDED 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%  
 $S_h = 4.0mm$   
DIST. TO NEG. MOVEMENT =  $1.5 \times 10 = 15m$   
  
VERT. SURFACE MOVEMENT = 0.04%  
 $S_v = 4mm$   
DIST. TO NEG. MOVEMENT =  $2 \times 10 = 20m$

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 =  $0.071\% \times 3m = 2.13mm$   
DIST. TO NEG. MOVEMENT = 6m

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

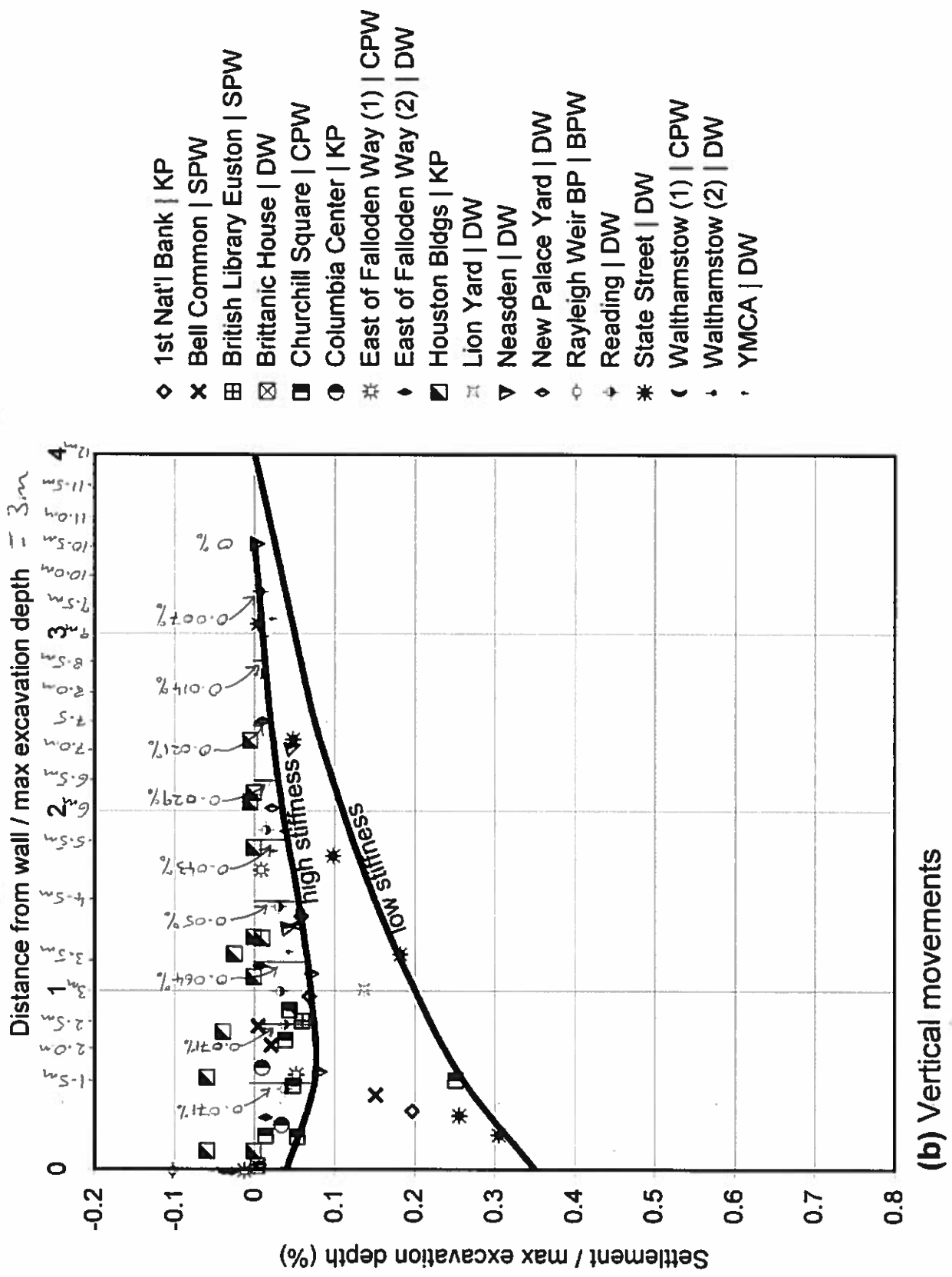
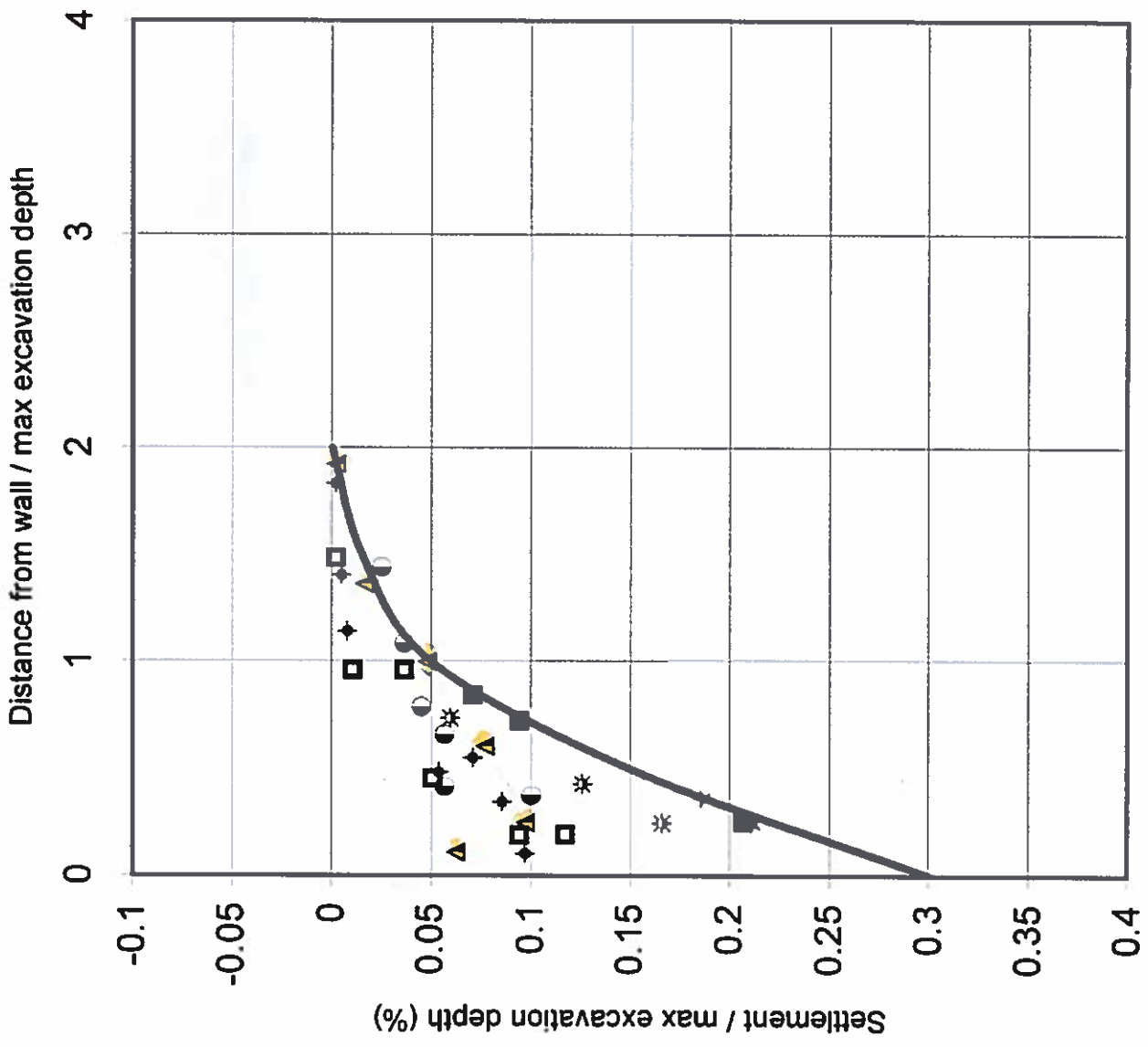


Figure 2.11 Ground surface movements due to excavation in front of wall in stiff clay





Key:

Site | Wall Type

SHP: Sheet pile wall — N/A } VERY FLEXIBLE WALLS - NOT APPLICABLE  
 KP: King post wall — N/A }  
 DW: Diaphragm wall

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

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

Table 2.2

Horizontal surface movement  
Distance to neg. movement

Vertical surface movement  
Distance to neg. movement

0.04%  
1.5

0.04%  
2

4 mm  
15 m  
0.27 mm/m

4 mm  
20 m  
0.20 mm/m

Ground Surface Movement due to Excavation in front of Wall

Depth of Excavation

3 m

Table 2.4

Horizontal surface movement  
Distance to neg. movement

0.15%  
4

4.5 mm  
12 m  
0.375 mm/m

Fig. 2.12

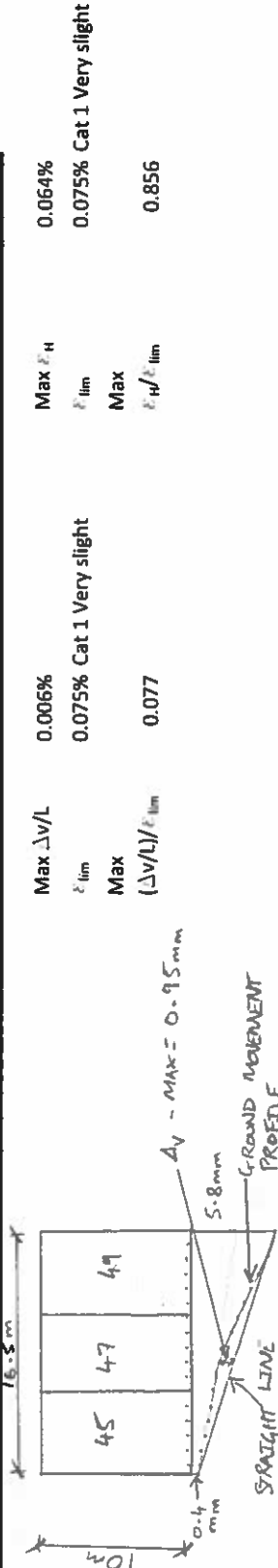
Vertical surface movement  
Distance to neg. movement

0.10%  
3.5

3 mm  
10.5 m  
0.29 mm/m

At 1.5 m		At 18 m	
Horizontal	Vertical	Horizontal	Vertical
3.60 mm	3.70 mm	0 mm	0.40 mm
7.54 mm	6.27 mm	0.00 mm	0.40 mm

Vertical Settlements along Building		Horizontal												
Pile Depth	Excavation Depth		Distance from Piles	Pile install movement (mm)	Distance/ excavation depth	Fig. 2.11 (%)	Total (mm)	Straight line along Elevation	$\Delta v$ (mm)	$\Delta v/L$	Pile install movement (mm)	Fig. 2.11 (a)	Total (mm)	Horizontal Strain $\epsilon_H$
	10 m	3 m												
0	0	0	4	0	0.050%	1.5	5.50				4	4.5	8.5	
1.5	3.70	0.50	3.70	0.50	0.070%	2.1	5.80	5.80	0.00	0.000%	3.60	3.94	7.54	0.064%
2.5	3.50	0.83	3.50	0.83	0.071%	2.13	5.63	5.47	0.16	0.001%	3.33	3.56	6.90	0.064%
3.5	3.30	1.17	3.30	1.17	0.064%	1.92	5.22	5.15	0.07	0.000%	3.07	3.19	6.25	0.064%
4.5	3.10	1.50	3.10	1.50	0.050%	1.5	4.60	4.82	-0.22	0.001%	2.80	2.81	5.61	0.064%
5.5	2.90	1.83	2.90	1.83	0.043%	1.29	4.19	4.49	-0.30	0.002%	2.53	2.44	4.97	0.064%
6.5	2.70	2.17	2.70	2.17	0.029%	0.87	3.57	4.16	-0.59	0.004%	2.27	2.06	4.33	0.064%
7.5	2.50	2.50	2.50	2.50	0.021%	0.63	3.13	3.84	-0.71	0.004%	2.00	1.69	3.69	0.064%
8.5	2.30	2.83	2.30	2.83	0.014%	0.42	2.72	3.51	-0.79	0.005%	1.73	1.31	3.05	0.064%
9.5	2.10	3.17	2.10	3.17	0.007%	0.21	2.31	3.18	-0.87	0.005%	1.47	0.94	2.40	0.064%
10.5	1.90	3.50	1.90	3.50	0.000%	0	1.90	2.85	-0.95	0.006%	1.20	0.56	1.76	0.064%
11.5	1.70	3.83	1.70	3.83	0.000%	0	1.70	2.53	-0.83	0.005%	0.93	0.19	1.12	0.064%
12.5	1.50	4.17	1.50	4.17	0.000%	0	1.50	2.20	-0.70	0.004%	0.67	0.00	0.67	0.045%
13.5	1.30	4.50	1.30	4.50	0.000%	0	1.30	1.87	-0.57	0.003%	0.40	0.00	0.40	0.027%
14.5	1.10	4.83	1.10	4.83	0.000%	0	1.10	1.55	-0.45	0.003%	0.13	0.00	0.13	0.027%
15.5	0.90	5.17	0.90	5.17	0.000%	0	0.90	1.22	-0.32	0.002%	0.00	0.00	0.00	0.013%
16.5	0.70	5.50	0.70	5.50	0.000%	0	0.70	0.89	-0.19	0.001%	0.00	0.00	0.00	0.000%
17.5	0.50	5.83	0.50	5.83	0.000%	0	0.50	0.56	-0.06	0.000%	0.00	0.00	0.00	0.000%
18	0.40	6.00	0.40	6.00	0.000%	0	0.40	0.40	0.00	0.000%	0.00	0.00	0.00	0.000%
18.5	0.30	6.17	0.30	6.17	0.000%	0	0.30	0.24	0.06	0.000%	0.00	0.00	0.00	0.000%
19	0.20	6.33	0.20	6.33	0.000%	0	0.20	0.07	0.13	0.001%	0.00	0.00	0.00	0.000%
20	0.00	6.67	0.00	6.67	0.000%	0	0.00	-0.25	0.25	0.002%	0.00	0.00	0.00	0.000%



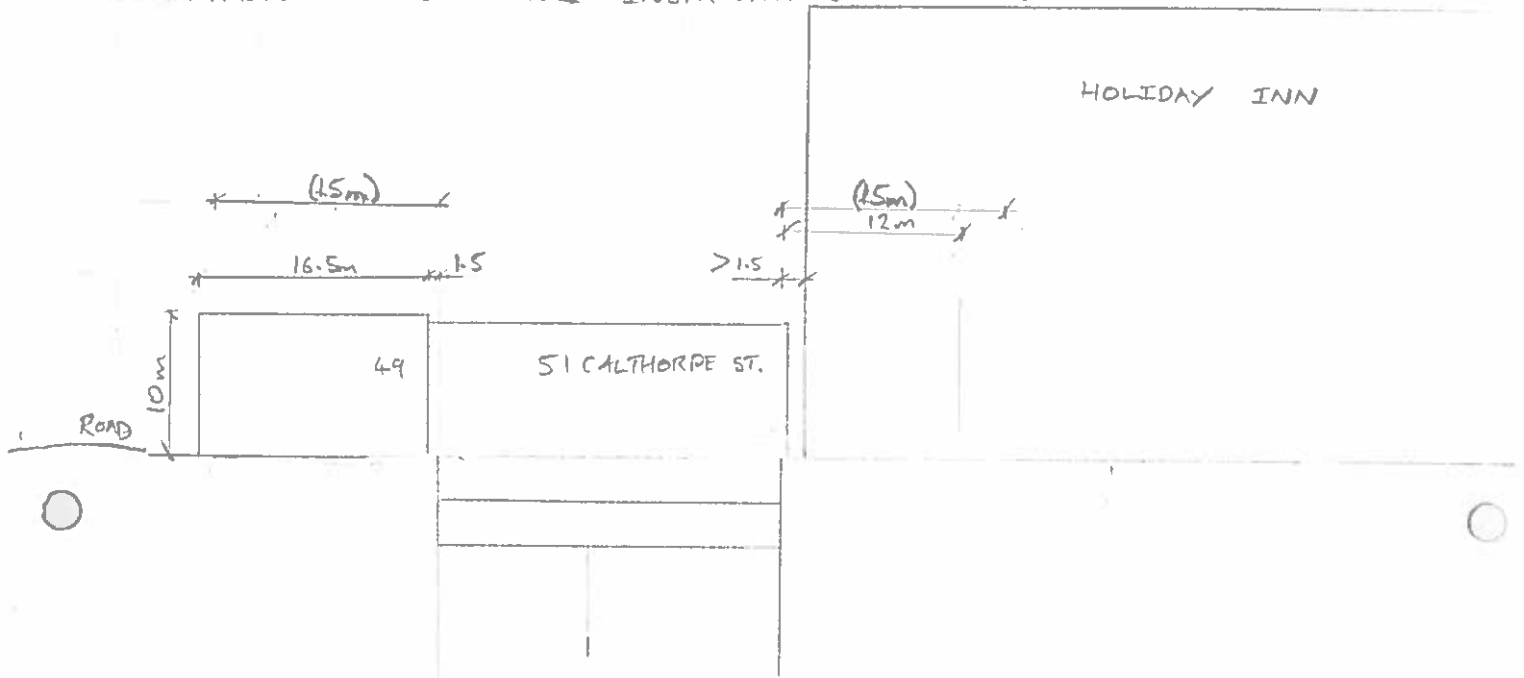
Max  $\epsilon_H$  0.064%  
 $\epsilon_{lim}$  0.075% Cat 1 Very slight  
 Max  $\epsilon_H/\epsilon_{lim}$  0.856

Max  $\Delta v/L$  0.006%  
 $\epsilon_{lim}$  0.075% Cat 1 Very slight  
 Max  $(\Delta v/L)/\epsilon_{lim}$  0.077

HORIZONTAL MOVEMENTS

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

7.54 mm MOVEMENT DUE TO PILE INSTALLATION + EXCAVATION



TOTAL = 7.54 mm @ 1.5m

AFFECTED ZONE = 15m FROM PILES

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

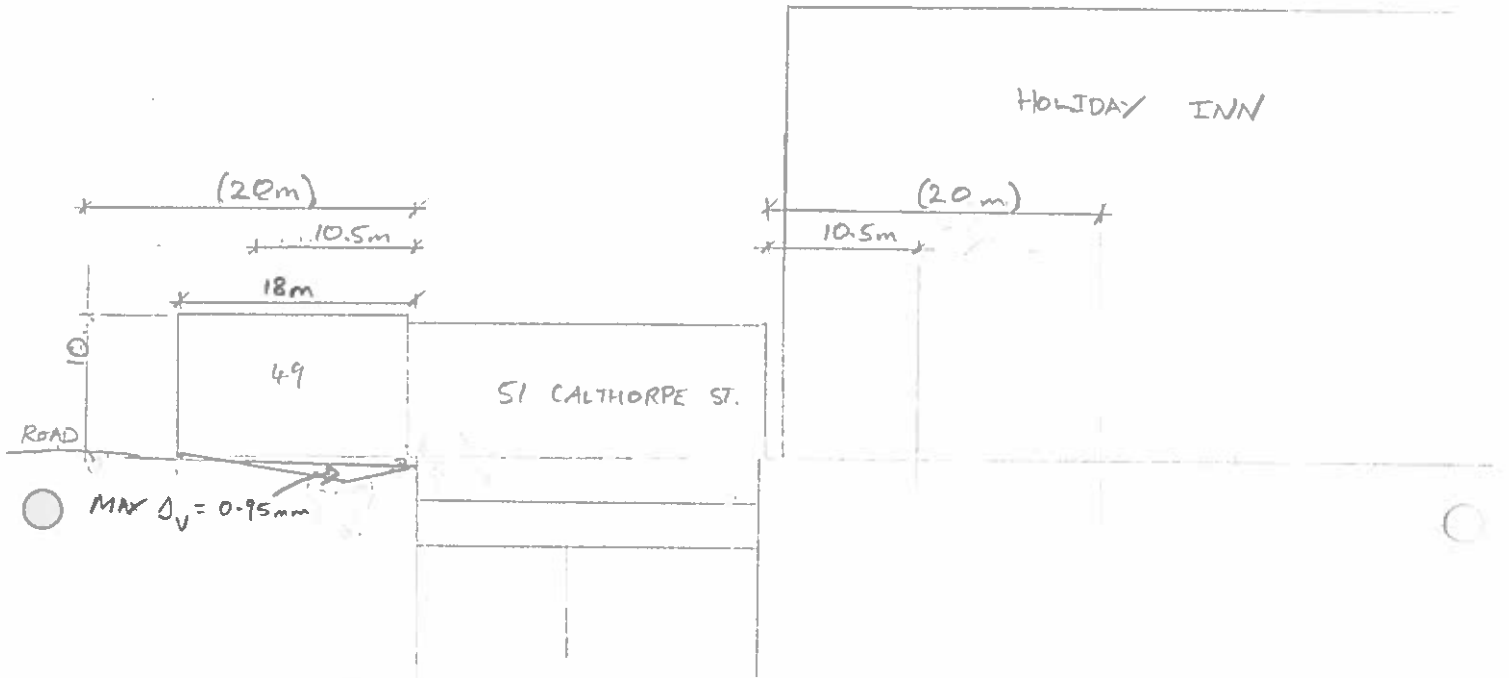
$E_{h \text{ max}} = 0.064$

$E_{\text{Lim}} = 0.075$  - VERY SLIGHT (CATEGORY I)

$\frac{E_h}{E_{\text{Lim}}} = \frac{0.064}{0.075} = 0.85$

VERTICAL MOVEMENTS

P/11  
REV. MARCH 2017



TOTAL CONSTRUCTION RELATED MOVEMENTS = 5.8mm

AFFECTED ZONE ≈ 20m

BUILDINGS > 1.5m FROM PILES:

DISPLACEMENTS AT 1.5m = 5.80mm

WORSE-CASE Δ<sub>v</sub> = 0.95mm

$$\Delta_v = 0.95 \text{ mm}$$

$$L = 16.5 \text{ m} \quad \rightarrow \quad \frac{\Delta}{L} = \frac{0.95}{16500} = 0.006 \%$$

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

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

**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**

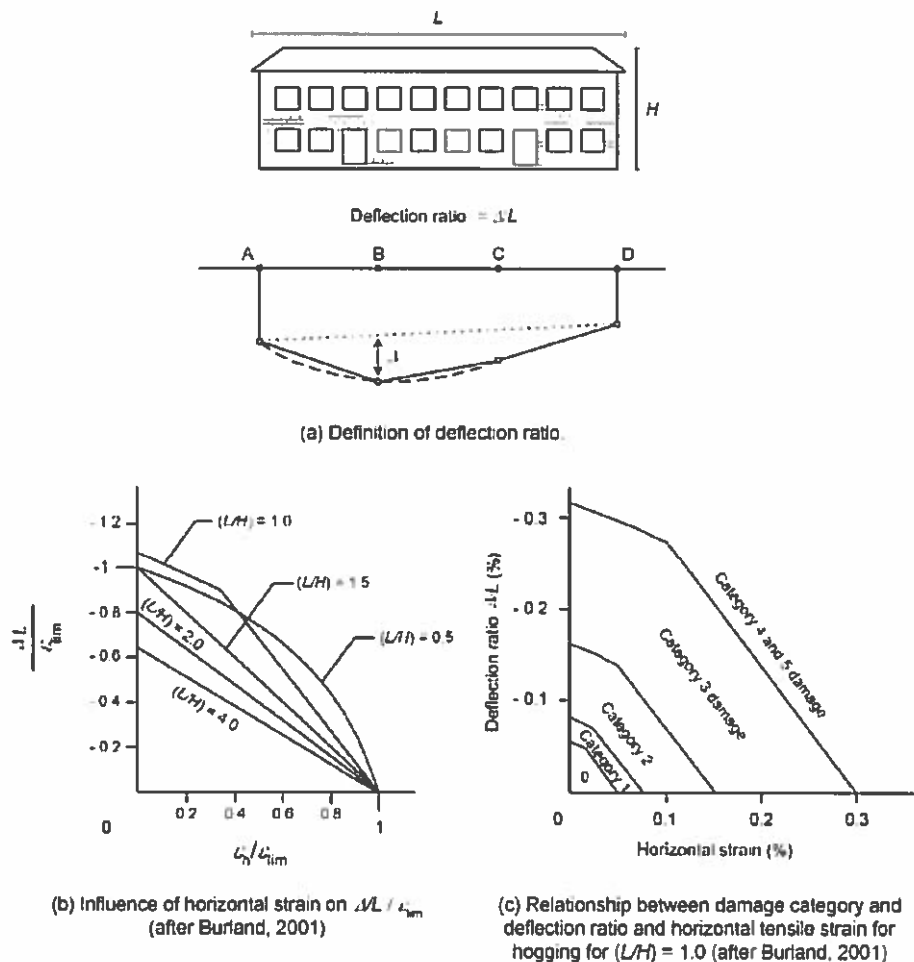
A condition survey should be carried out on all structures and utilities within the zone of influence before starting work on site. The structure or utility should be assumed to follow the ground (ie it has negligible stiffness), so the distortions and consequently the strains in the structure or utility 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 $\epsilon_{lim}$ (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	<u>Fine cracks that can easily be treated during normal decoration.</u> Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection.	< 1	0.05–0.075
2 Slight	<u>Cracks easily filled. Redecoration probably required.</u> Several slight fractures showing inside of building. Cracks are visible externally and <u>some repointing may be required externally</u> to ensure weathertightness. Doors and windows may stick slightly.	< 5	0.075–0.15
3 Moderate	<u>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.</u> 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	<u>Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.</u> 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	<u>This requires a major repair involving partial or complete rebuilding.</u> 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.



By adopting values of  $\epsilon_{tm}$  associated with the various damage categories given in Table 2.5, Figure (b) can be developed into an interaction diagram showing the relationship between  $\Delta L$  and  $\epsilon_h$  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  $(\Delta/L)$  and  $\epsilon_h$  for the required  $(L/H)$  from Figure 2.18(b) for  $\epsilon_{tm}$  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  $(\Delta/L)$  and  $\epsilon_h (= \delta_h/L)$  where  $\delta_h$  is the horizontal movement
- (vi) estimate damage category from the relationship between  $(\Delta/L)$  and  $\epsilon_h$  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  $\frac{\Delta}{L}/E_{lim}$  @  $\frac{E_H}{E_{lim}} = 0 = 0.94$   
 $\therefore$  LINE =  $0.94 - 0.94 \times \frac{E_H}{E_{lim}}$

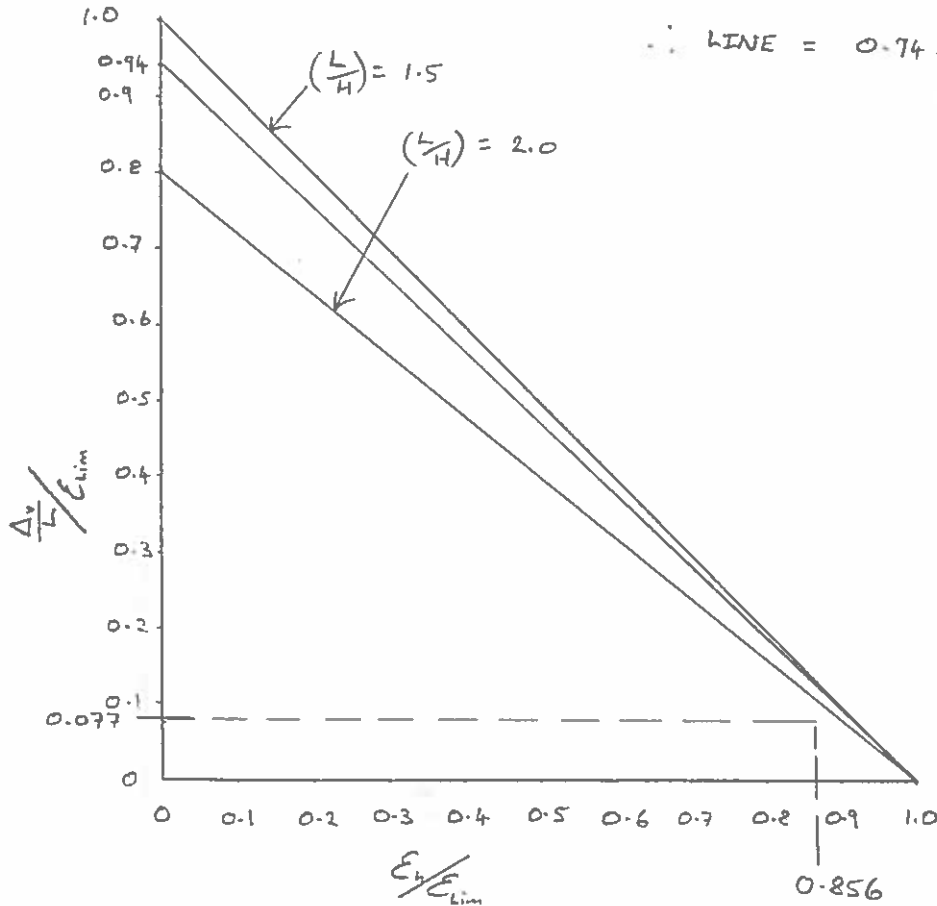


FIG. 2.18(b)

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

$$\frac{E_H}{E_{lim}} = 0.856$$

CHECK COMBINED STRAINS ARE UNDER LINE:

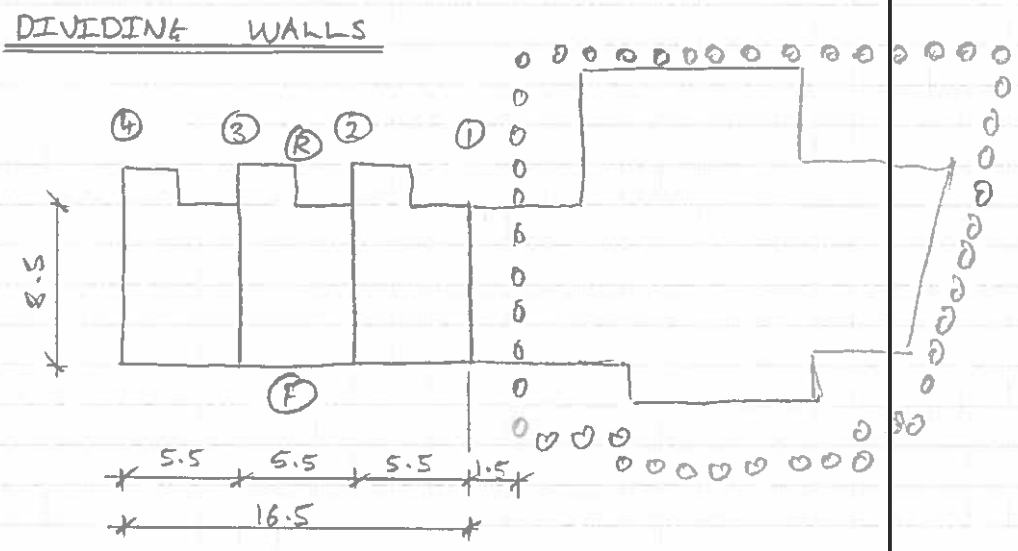
$$\text{MAX. } \frac{\Delta}{L}/E_{lim} = 0.94 - 0.94 \times 0.856 = 0.135$$

$$\text{ACTUAL} = 0.077 \therefore \text{O.K.}$$

CATEGORY 1 - VERY SLIGHT



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



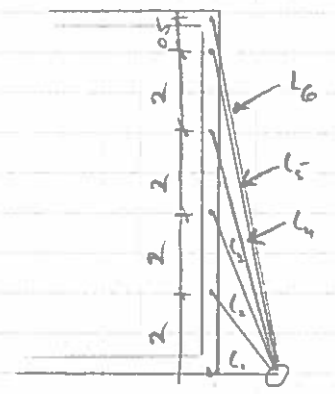
WALL ON ①

DIST. FROM PILES = 1.5m  
 $L = 8.5m$   
 $H = 10m$  →  $\frac{L}{H} = 0.85$

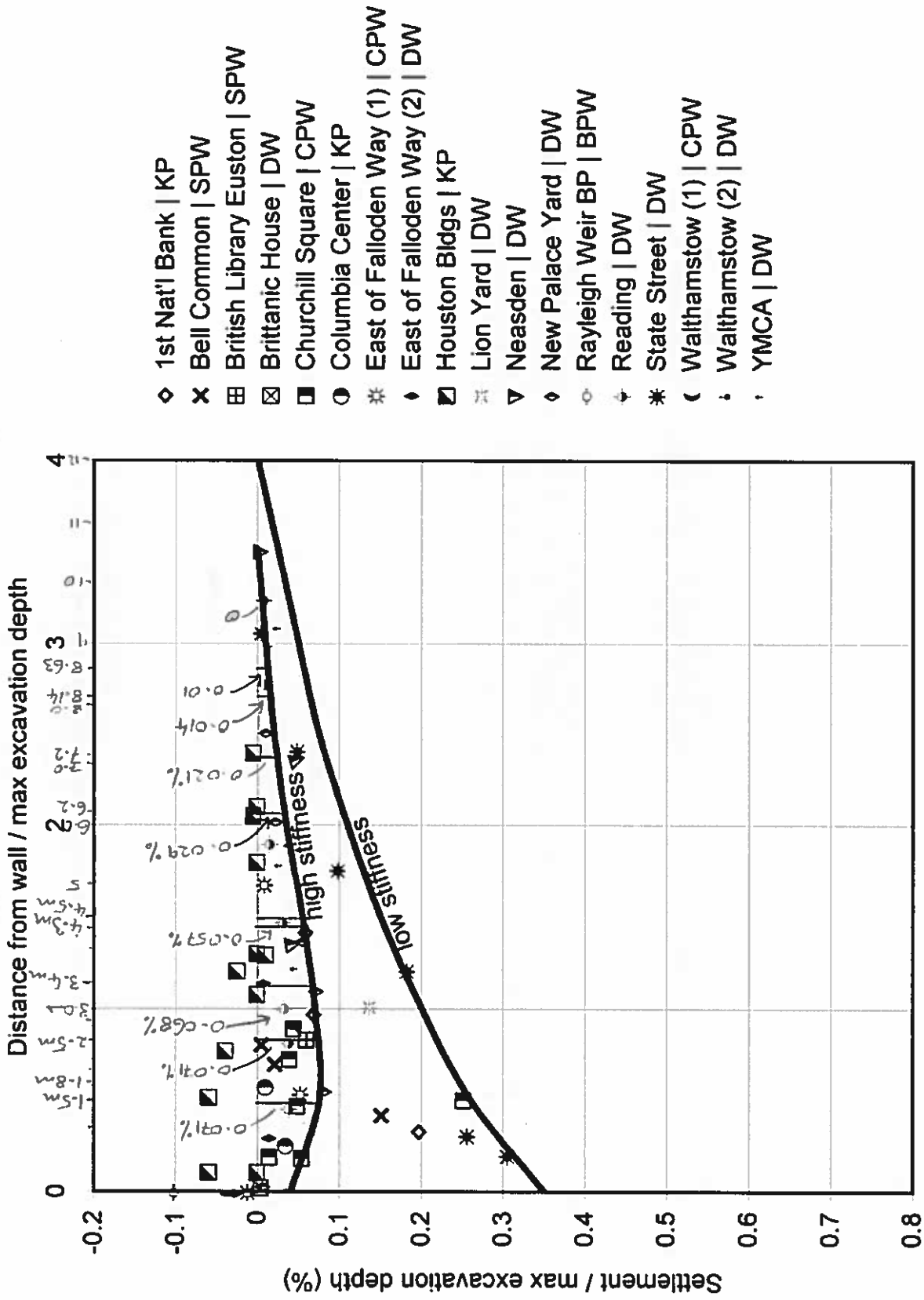
GEN. MOVEMENT CONSISTENT ALONG WALL EXPECTED. FOR CONSERVATISM CHECK CASES WITH LOCALISED SETTLEMENT ONLY:

CASE 1

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

	<u>DIST</u>	<u>MAX. EXCAVATION DEPTH</u>
	$L_1 = 1.5m$	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

DIVIDING WALL ON LINE 1



(b) Vertical movements

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

Vertical Settlements Dividing Wall - Case 1		Horizontal										
Pile Depth	10 m											
	3 m											
Excavation Depth	Pile install movement (mm)	Distance/ excavation depth	Fig. 2.11 (%)	Total (mm)	Straight line along Elevation	$\Delta v$ (mm)	$\Delta v/L$	Pile install movement (mm)	Fig. 2.11 (a) (mm)	Total (mm)	Horizontal Strain $\epsilon_H$	
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	3.60	3.94	7.54	0.064%	
2.5	3.50	0.83	0.071%	2.13	5.63	5.35	0.28	3.33	3.56	6.90	0.064%	
3	3.40	1.00	0.068%	2.04	5.44	5.12	0.32	3.20	3.38	6.58	0.064%	
4.3	3.14	1.43	0.057%	1.71	4.85	4.53	0.32	2.85	2.89	5.74	0.064%	
6.2	2.76	2.07	0.029%	0.87	3.63	3.67	-0.04	2.35	2.18	4.52	0.064%	
7.2	2.56	2.40	0.021%	0.63	3.19	3.22	-0.03	2.08	1.80	3.88	0.064%	
8.14	2.37	2.71	0.014%	0.42	2.79	2.80	0.00	1.83	1.45	3.28	0.064%	
8.63	2.27	2.88	0.010%	0.3	2.57	2.57	0.00	1.70	1.26	2.96	0.064%	
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		

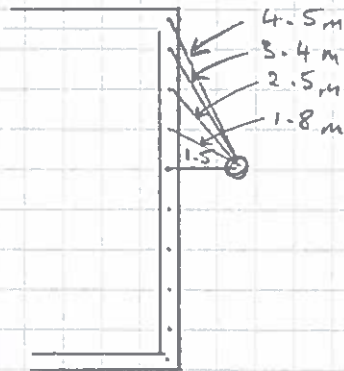
Max  $\Delta v/L$  0.004%  
 $\epsilon_{lim}$  0.075% Cat 1 Very slight  
 Max  $(\Delta v/L)/\epsilon_{lim}$  0.050  
 Max  $\epsilon_H$  0.064%  
 $\epsilon_{lim}$  0.075% Cat 1 Very slight  
 Max  $\epsilon_H/\epsilon_{lim}$  0.856

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Project: 51 CALTHORPE STREET	Sheet no. of Calc. no: A/17	Job No: Checked by:
Subject: 49 CALTHORPE ST - DIV. WALL CHECK	Made by: PMO Date: 28/03/2015	Date:

CASE 2

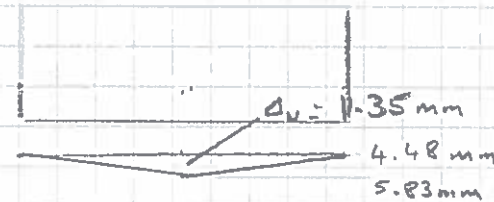
CENTRAL DEFLECTION, NO MOVEMENT AT ENDS



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.  $\Delta_H = 7.54\text{mm} - 5.61\text{mm}$

$\Delta_H = 1.93\text{mm}$

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

$\frac{E_H}{E_{lim}} = \frac{0.023}{0.075} = 0.3$

49 Calthorpe Street Ground Movement Assessment

P/18a

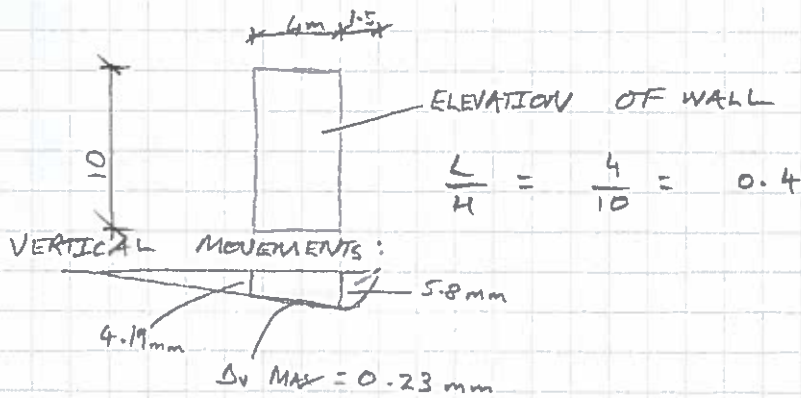
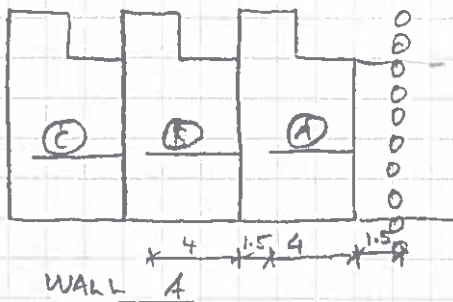
Pile Depth	Vertical Settlements Dividing Wall - Case 2					Horizontal							
	10 m		3 m			Total (mm)	Straight line along Elevation	$\Delta v$ (mm)	$\Delta w/L$	Pile install movement (mm)	Fig. 2.11 (a) (mm)	Total (mm)	Horizontal Strain $\epsilon_H$
	Excavation Depth	Pile install movement (mm)	Distance/ excavation depth	Fig. 2.11 (%)	(mm)								
0	4	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	5.83	0.00	3.60	3.94	7.54		
1.8	3.64	0.60	0.078%	2.34	5.98	5.69	5.69	0.29	3.52	3.83	7.35		
2.5	3.50	0.83	0.071%	2.13	5.63	5.38	5.38	0.25	3.33	3.56	6.90		
3.4	3.32	1.13	0.064%	1.92	5.24	4.97	4.97	0.27	3.09	3.23	6.32		
4.5	3.10	1.50	0.050%	1.5	4.60	4.48	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		

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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



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

HORIZONTAL MOVEMENTS

$$\text{MAX. } \epsilon_H = 0.064\%$$

REFERING TO PAGE P/19 GRAPH:

$$\frac{\epsilon_H}{\epsilon_{lim}} = \frac{0.064}{0.075} = 0.856$$

$$\frac{\Delta v}{\epsilon_{lim}} = \frac{0.006}{0.075} = 0.08$$

WALL A  
= WORSE CASE

Pile Depth	Vertical Settlements along Spine Walls					Horizontal							
	10 m		3 m			Total (mm)	Straight line along Elevation	$\Delta v$ (mm)	$\Delta v/L$	Pile install movement (mm)	Fig. 2.11 (a) (mm)	Total (mm)	Horizontal Strain $\epsilon_H$
	Excavation Depth	Pile install movement (mm)	Distance/ excavation depth	Fig. 2.11 (%)	(mm)								
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	0.064%	
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%	
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%	
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%	
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%	
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		
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%	
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%	
10	2.00	3.33	0.000%	0	2.00	2.19	-0.19	0.005%	1.33	0.75	2.08	0.064%	
11	1.80	3.67	0.000%	0	1.80	1.80	0.00	0.000%	1.07	0.38	1.44	0.064%	
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		
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%	
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%	
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%	
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%	
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		

W

A

L

L

A

W

A

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B

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A

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C

49 CALTHORPE ST.  
DIVIDING WALL

P/19

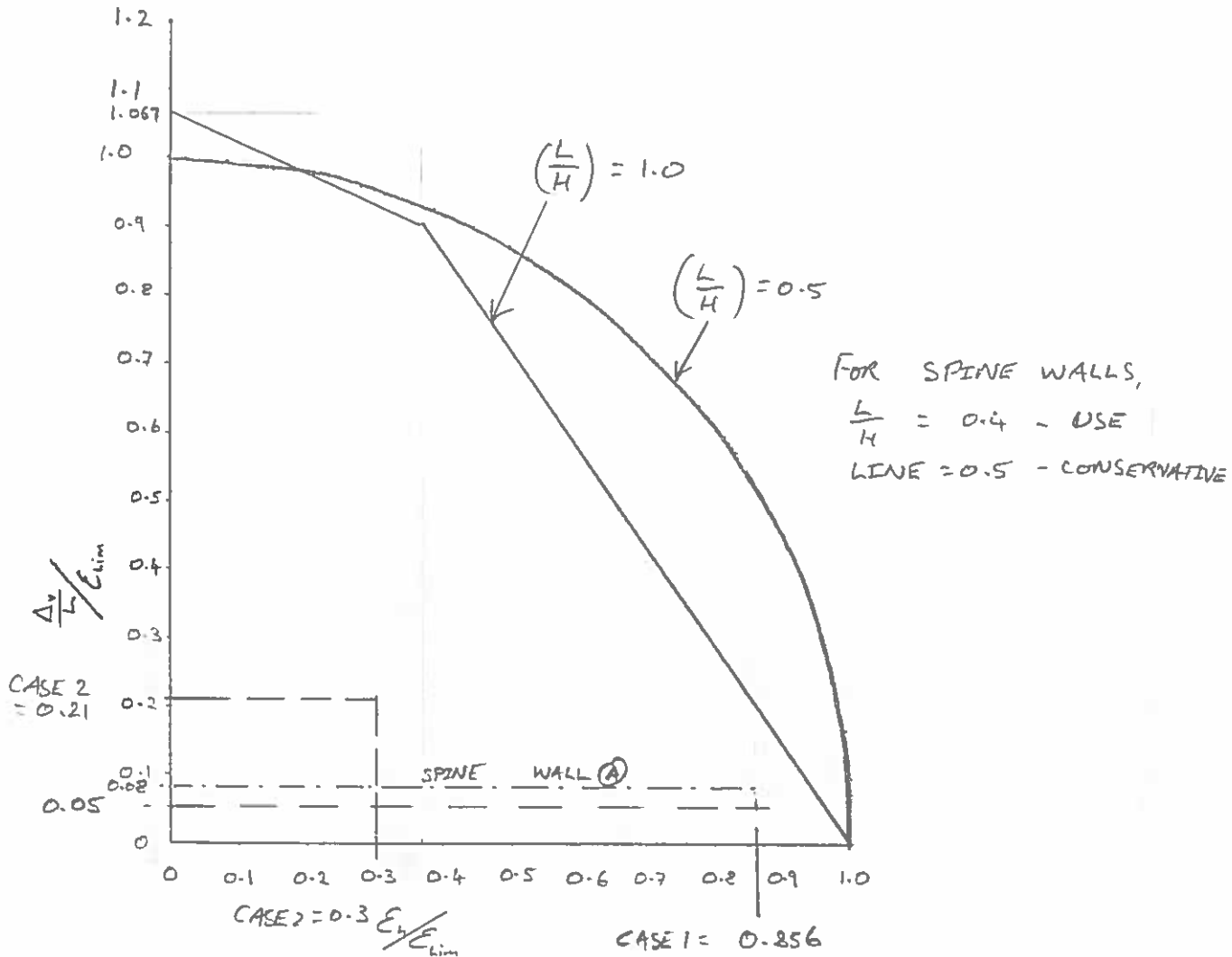


FIG. 2.18(b)

DIVIDING WALL:

CASE 1:  $\frac{E_h}{E_{lim}} = 0.856$        $\frac{\Delta/L}{E_{lim}} = 0.05$

∴ O.K. - CAT. 1 VERY SLIGHT

CASE 2:  $\frac{E_h}{E_{lim}} = 0.3$        $\frac{\Delta/L}{E_{lim}} = 0.21$

∴ O.K. - CAT. 1 VERY SLIGHT

SPINE WALL A:  $\frac{E_h}{E_{lim}} = 0.856$ ,  $\frac{\Delta/L}{E_{lim}} = 0.08$  → O.K. CAT 1.

DIVIDING WALLS ALL WITHIN  
CATEGORY 1 - VERY SLIGHT

SPINE WALLS ALL WITHIN  
CATEGORY 1 - VERY SLIGHT





Project: SI CALTHORPE ST BIA	Sheet no. of	Job No: P12-325
	Calc. no: P/20	Checked by:
Subject: CLASSIFICATION OF VISIBLE DAMAGE CHECKS MIXED USE SCHEME	Made by: REV. MAR 2017 AMO	Date:
	Date: 01/9/16	

CHECK ON HOLIDAY INN

HOLIDAY INN HAS A BASEMENT OF SIMILAR SIZE / DEPTH TO THAT PROPOSED AT SI 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 : 15m HORIZ.  
 20m VERT.

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

HORIZONTAL STRAINS :

$$E_h = \frac{3.6}{15000} = 0.024\%$$

FOR V. SLIGHT CATEGORY :  $\frac{0.024}{0.075} = 0.32$   
 FOR NEG. :  $\frac{0.024}{0.05} = 0.48$

VERTICAL

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

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

Horizontal surface movement Distance to neg. movement	0.04% 1.5	4 mm 15 m 0.27 mm/m
Vertical surface movement Distance to neg. movement	0.04% 2	4 mm 20 m 0.20 mm/m

Ground Surface Movement due to Excavation in front of Wall

Depth of Excavation 3 m

Horizontal surface movement Distance to neg. movement	0.00% 4	0 mm 12 m 0.00 mm/m
Vertical surface movement Distance to neg. movement	0.00% 3.5	0 mm 10.5 m 0.00 mm/m

At 1.5 m		At 52 m	
Horizontal	Vertical	Horizontal	Vertical
3.60 mm	3.70 mm	0 mm	0.00 mm
0.00 mm	0.00 mm	0.00 mm	0.00 mm
3.60 mm	3.70 mm	0.00 mm	0.00 mm

Table 2.2

Table 2.4

Fig. 2.12

HOLIDAY INN

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

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

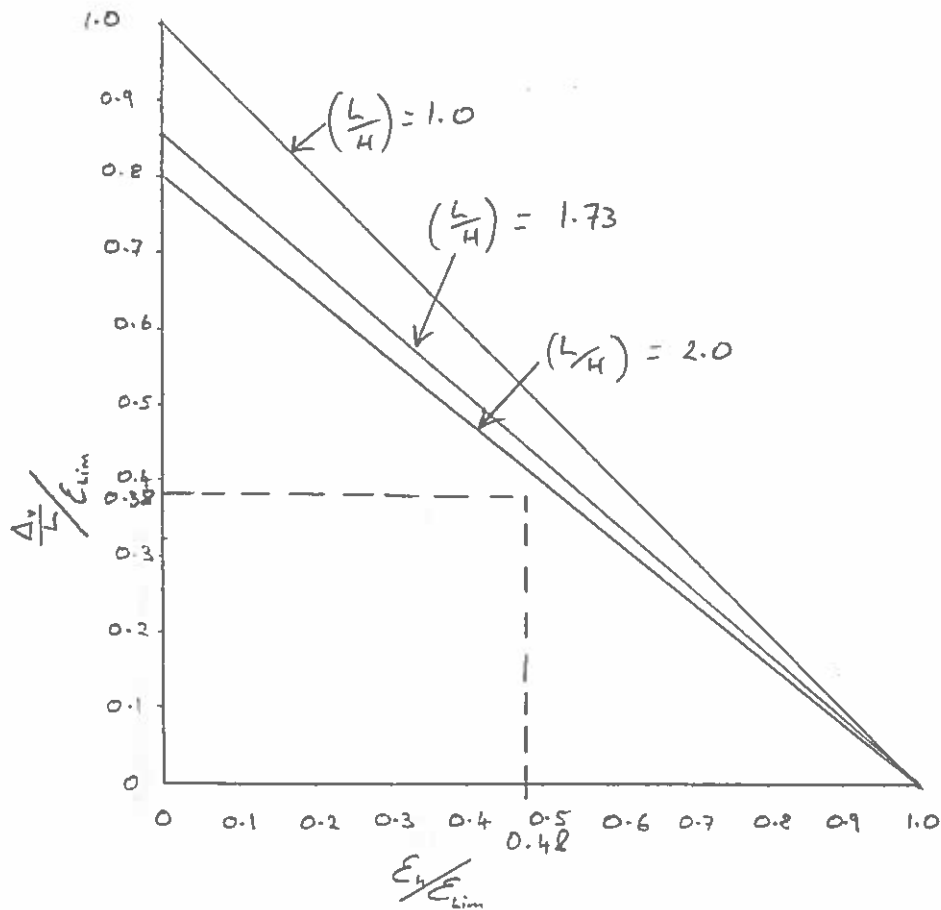


FIG. 2.18(b)

$$\frac{\Delta/L}{E_{lim}} = 0.38$$

$$\frac{E_n}{E_{lim}} = 0.48$$

CHECK COMBINED STRAINS ARE UNDER LINE:

$$\text{MAX. } \frac{\Delta/L}{E_{lim}} = 0.85 - 0.85 \times 0.32 = 0.578$$

ACTUAL =  $\therefore$  O.K.

$\therefore$  CATEGORY 0 - NEGLIGIBLE



Project: SI CALTHORPE ST BIA	Sheet no. of Calc. no: P/23	Job No: Checked by:
Subject: CLASSIFICATION OF VISIBLE DAMAGE ASSESSMENT	Made by: REV. MARCH 2017 Date: 09/09/16	Date:

EFFECTS ON ROAD

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

AT 5m FROM PILES, <sup>VERT.</sup> MOVEMENTS ≈ 0.02%  
= 0.6mm

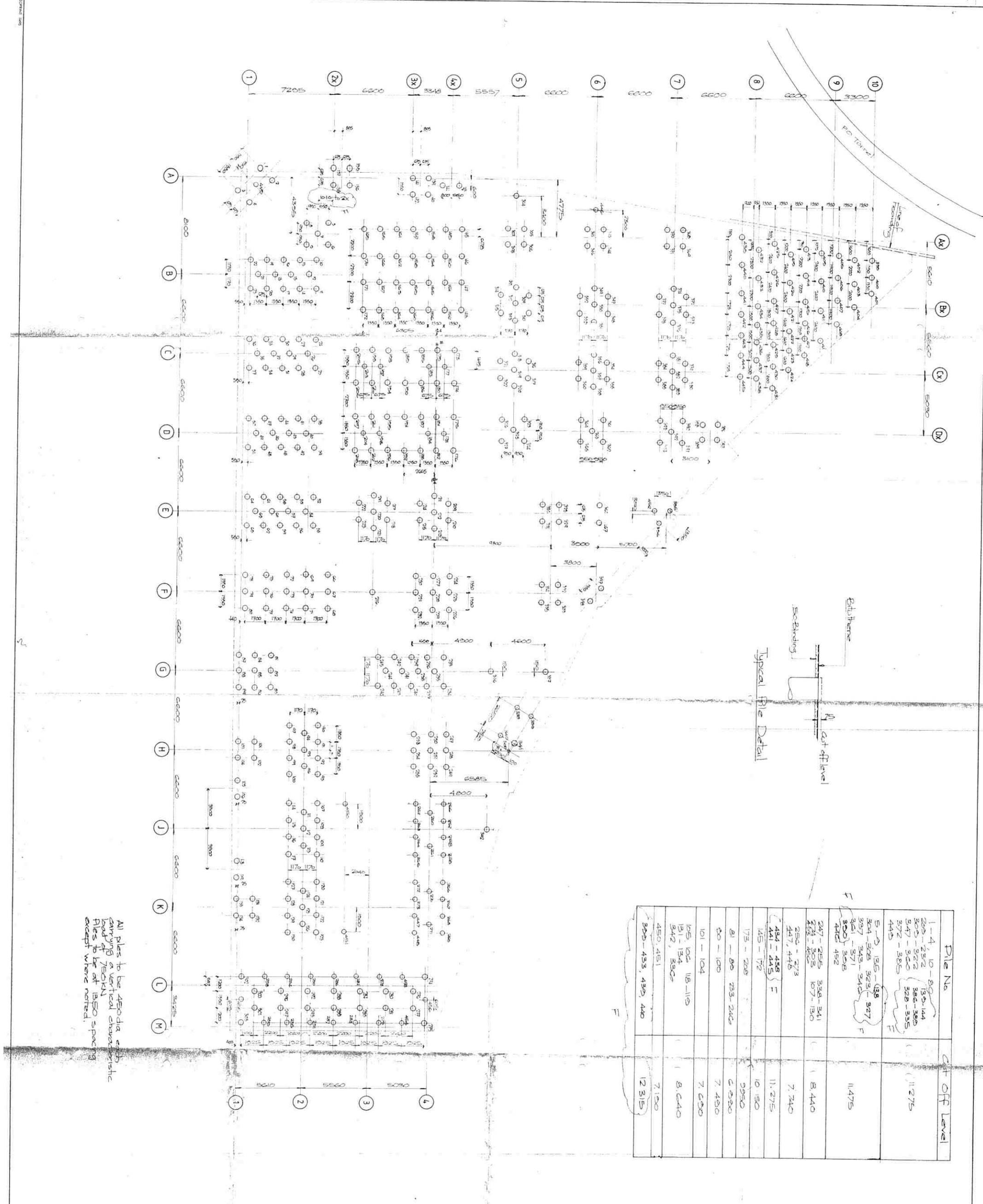
HORIZONTAL = 2.67mm + 0.88 = 3.54mm

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**



Pile No	Cut Off Level
1-4, 10-20	11.275
201-252	11.475
253-304	
305-356	
357-408	
409-460	
461-512	
513-564	
565-616	
617-668	
669-720	
721-772	
773-824	
825-876	
877-928	
929-980	
981-1032	
1033-1084	
1085-1136	
1137-1188	
1189-1240	
1241-1292	
1293-1344	
1345-1396	
1397-1448	
1449-1500	
1501-1552	
1553-1604	
1605-1656	
1657-1708	
1709-1760	
1761-1812	
1813-1864	
1865-1916	
1917-1968	
1969-2020	
2021-2072	
2073-2124	
2125-2176	
2177-2228	
2229-2280	
2281-2332	
2333-2384	
2385-2436	
2437-2488	
2489-2540	
2541-2592	
2593-2644	
2645-2696	
2697-2748	
2749-2800	
2801-2852	
2853-2904	
2905-2956	
2957-3008	
3009-3060	
3061-3112	
3113-3164	
3165-3216	
3217-3268	
3269-3320	
3321-3372	
3373-3424	
3425-3476	
3477-3528	
3529-3580	
3581-3632	
3633-3684	
3685-3736	
3737-3788	
3789-3840	
3841-3892	
3893-3944	
3945-3996	
3997-4048	
4049-4100	
4101-4152	
4153-4204	
4205-4256	
4257-4308	
4309-4360	
4361-4412	
4413-4464	
4465-4516	
4517-4568	
4569-4620	
4621-4672	
4673-4724	
4725-4776	
4777-4828	
4829-4880	
4881-4932	
4933-4984	
4985-5036	
5037-5088	
5089-5140	
5141-5192	
5193-5244	
5245-5296	
5297-5348	
5349-5400	
5401-5452	
5453-5504	
5505-5556	
5557-5608	
5609-5660	
5661-5712	
5713-5764	
5765-5816	
5817-5868	
5869-5920	
5921-5972	
5973-6024	
6025-6076	
6077-6128	
6129-6180	
6181-6232	
6233-6284	
6285-6336	
6337-6388	
6389-6440	
6441-6492	
6493-6544	
6545-6596	
6597-6648	
6649-6700	
6701-6752	
6753-6804	
6805-6856	
6857-6908	
6909-6960	
6961-7012	
7013-7064	
7065-7116	
7117-7168	
7169-7220	
7221-7272	
7273-7324	
7325-7376	
7377-7428	
7429-7480	
7481-7532	
7533-7584	
7585-7636	
7637-7688	
7689-7740	
7741-7792	
7793-7844	
7845-7896	
7897-7948	
7949-7999	

All piles to be 430 dia each carrying a vertical characteristic load of 750 kN. Piles to be at 1850 spacing except where noted.

Surveyor to the Building Owners:  
Surveyor to the Architect/Engineers:

**R. J. CROCKER & PARTNERS**  
CONSULTING ENGINEERS  
11 Bedford Park, Fremont, New South Wales  
Telephone: (02) 943 9300  
Facsimile: (02) 943 9301  
Website: www.rjc.com.au

PROJECT: 4252  
DATE: 11/02  
SCALE: 1:100

PROJECT: PILING LAYOUT  
CLIENT: SELFERT  
PROJECT NAME: KINGS CROSS HOLIDAY INN

REVISIONS:  
A. Retention  
B. Pile cut off levels added 20/12  
C. Setting out piles 330-341  
D. Piles not 145m apart cut off level amended  
E. Piles 330-341 amended  
F. Piles 330-341 amended  
G. Piles 330-341 amended  
H. Piles 330-341 amended  
I. Piles 330-341 amended  
J. Piles 330-341 amended  
K. Piles 330-341 amended  
L. Piles 330-341 amended  
M. Piles 330-341 amended

NOTES:  
1. THIS DRAWING TO BE READ WITH THE SPECIFICATION AND BILL OF MATERIALS AND ALL OTHER RELEVANT DRAWINGS.  
2. THIS DRAWING MUST NOT BE SCALED. DIMENSIONS TO BE CHECKED WITH ARCHITECT'S DETAILS.