

**Appendix F**  
**Ground Movement Assessment Calculations (Stage 4)**

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWR2950

Site: 26 West Hill Park

Excavation Depth: 1.5

**Neighbouring Property 1**

House No.	23 Merton Lane Wall 1
Closest Wall (m)	0.00
Length (m)	14.10
Furthest Wall (m)	14.10
Height	6.39

**Neighbouring Property 2**

House No.	
Closest Wall (m)	
Length (m)	
Furthest Wall (m)	
Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

**Distance to Negligible Movement**

Horizontal:	6
Vertical:	5.25

Fig 2.11

Neighbouring Property 1 No. 23 Merton Lane Wa Interval 3.53

Contour Plot Point	Distance (m)	Distance/Max Excavation Depth		
		Distance (m)	Excavation Depth	
A	0.00	0.00	0.00	
B	3.53	2.35	1.57	
D	7.05	4.70	3.13	
E	10.58	7.05	4.70	
F	14.10	9.40	6.27	

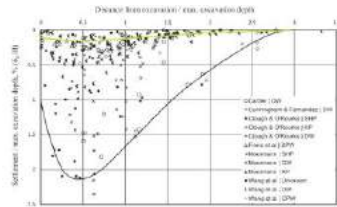
  

Horizontal Movement				
Distance (m)	%	(m)	(mm)	
0.00		0.15	0.00225	8.88 Movement at closest wall
3.53		0.06	-0.00099	
7.05		-0.03	-0.00039	
10.58		-0.11	-0.00172	
14.10		-0.20	-0.00304	0.00 Movement at furthest wall

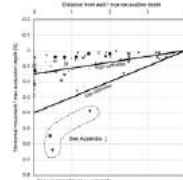
  

Vertical Movement				
Distance (m)	%	(m)	(mm)	
0.00		0.04	0.00060	7.65 Movement at closest wall
3.53		0.03	-0.00049	5.30
7.05		-0.03	-0.00052	2.30
10.58		-0.10	-0.00152	0.70
14.10		-0.17	-0.00255	0.0045 Movement at furthest wall

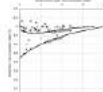
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



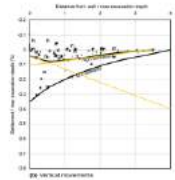
Normalised settlements due to excavation in soft to firm clay



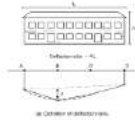
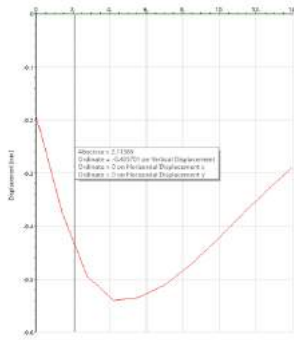
Horizontal movement calls linear relationship from graph



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



**Potential Damage to Building**



Neighbouring Property 1 No. 23 Merton Lane Wall 1

	m	mm
L	14.10	14100
H	6.39	6390
L/H	2.21	

Vertical Deflection ( $\Delta$ )	0.29 mm	from graph (max difference between blue and orange line)
Deflection Ratio ( $\Delta/L$ )	0.002057 %	
Horizontal Movement ( $\delta h$ )	0.38 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ( $\epsilon_h$ ) = $\delta h/L$	0.00270 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

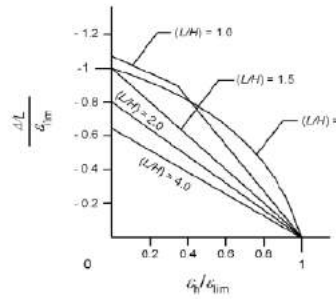
L/H	2.21	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0.041134752	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0.053900709	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0.027423168	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0.035938006	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0.013711584	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0.017966903	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0.006855792	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $\epsilon_h$ )/(Elim)	0.008983452	

Calculated Category of Damage Negligible

L/H	0.00	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $\epsilon_h$ )/(Elim)	0	

Calculated Category of Damage Negligible

Fig 2.18 (b)



(b) Influence of horizontal strain on  $\Delta/L / \epsilon_{lim}$  (after Burland, 2001)

Table 2.5

Category of damage	Description of typical damage (note or repair as indicated)	Approximate crack widths (mm)	Limiting crack widths (mm)
0 Negligible	Minor cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during normal decoration. There is isolated slight distress in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks small, blind. Reproduction probably original. Several slight distresses around joints of building. Cracks are visible externally and minor repointing may be required externally to ensure weathertightness. Doors and windows stay close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mason. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes show fracture. Weathertightness often impaired.	3-15 or more	0.15-0.3
4 Severe	Extensive cracks with cracking breaking out and spalling sections of walls, especially over doors and windows. Windows and frames distorted. Door staying inoperative. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but may exceed	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Doors are inoperative, walls are badly and require closing. Windows broken. Walls bowing. Degree of instability.	more than 25	> 0.3

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWR2950  
 Site: 26 West Hill Park  
 Excavation Depth: 1.5

Neighbouring Property 1		Neighbouring Property 2	
House No.	23 Merton Lane Wall 2	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	25.30	Length (m)	
Furthest Wall (m)	25.30	Furthest Wall (m)	
Height	6.39	Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

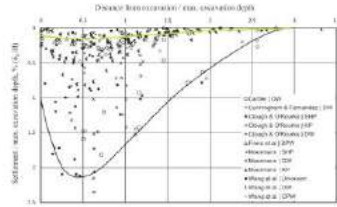
**Distance to Negligible Movement**

Direction	(m)
Horizontal	6
Vertical	5.25

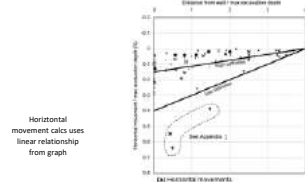
Fig 2.11

Neighbouring Property 1		No. 23 Merton Lane Wa	Interval	6.33	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth			
	A	0.00			
	B	6.33	4.22		
	D	12.65	8.43		
	E	18.98	12.65		
F	25.30	16.87			
Distance (m)	%	(m)	Horizontal Movement (mm)		
	0.00	0.15	0.88	Movement at closest wall	
	6.33	0.01	0.00		
	12.65	-0.17	0.00		
	18.98	-0.32	0.00	Movement at furthest wall	
25.30	-0.48				

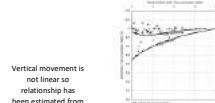
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



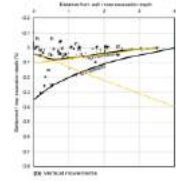
Normalised settlements due to excavation in soft to firm clay



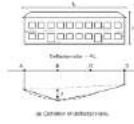
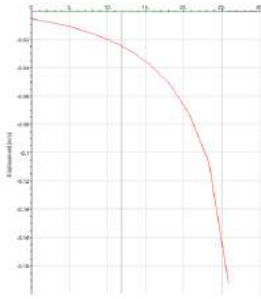
Horizontal movement calls uses linear relationship from graph



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



**Potential Damage to Building**



**Neighbouring Property 1**      No. 23 Merton Lane Wall 2

L	m	mm
H	25.30	25300
L/H	6.39	6390
L/H	3.96	

Vertical Deflection (Δ)	0.08 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000316 %	
Horizontal Movement (δh)	0.38 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (Eh) = δh/L	0.00150 %	

**CATEGORY OF DAMAGE**      Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

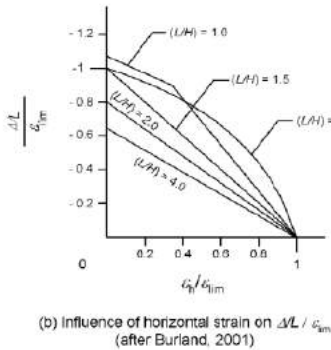
L/H	3.96
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
(Δ/L)/(Elim)	0.006324111
(Eh)/(Elim)	0.030039526
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>
(Δ/L)/(Elim)	0.004216074
(Eh)/(Elim)	0.02002635
<b>Slight damage limit (Elim)</b>	<b>0.15</b>
(Δ/L)/(Elim)	0.002108037
(Eh)/(Elim)	0.010013175
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>
(Δ/L)/(Elim)	0.001054018
(Eh)/(Elim)	0.00506588

**Calculated Category of Damage**      Negligible

L/H	0.00
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
(Δ/L)/(Elim)	0
(Eh)/(Elim)	0
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>
(Δ/L)/(Elim)	0
(Eh)/(Elim)	0
<b>Slight damage limit (Elim)</b>	<b>0.15</b>
(Δ/L)/(Elim)	0
(Eh)/(Elim)	0
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>
(Δ/L)/(Elim)	0
(Eh)/(Elim)	0

**Calculated Category of Damage**      Negligible

**Fig 2.18 (b)**



**(b) Influence of horizontal strain on ΔL / c<sub>lim</sub> (after Burland, 2001)**

**Table 2.5**

Classification of visible damage to walls (after Burland et al, 1977; Vincennes and Gording, 1986 and Dolan, 2001)

Category of damage	Description of typical damage (note of repair is indicated)	Approximate crack width (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible	< 0.1	0.1-0.05
1 Very slight	Fine cracks that can easily be sealed during annual maintenance. The loss is not light fracture in loading. Cracks in external brickwork visible on inspection.	< 1	0.25-0.675
2 Slight	Cracks that are visible. Repairs are usually required. Several slight fractures around joints of loading. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may close slightly.	< 3	0.675-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.1
4 Severe	Extensive cracks with serious breaking-out and spalling of mortar. Repairs are extensive. Doors and windows. Windows and frames distorted. Some stopping internally. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but one depends on number of cracks > 1	> 0.3
5 Very severe	The masonry is more than seriously cracked or completely destroyed. Doors are unusable, walls are badly and require closing. Windows broken. Walls leaning. Degree of instability.	usually > 25	> 0.3

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWR2950  
 Site: 26 West Hill Park  
 Excavation Depth: 1.5

Neighbouring Property 1		Neighbouring Property 2	
House No.	23 Merton Lane Wall 3	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	17.20	Length (m)	
Furthest Wall (m)	17.20	Furthest Wall (m)	
Height	6.39	Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

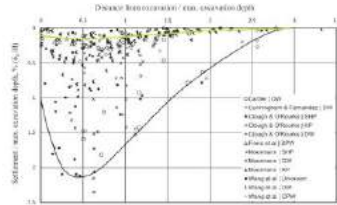
**Distance to Negligible Movement (m)**

Horizontal:	6
Vertical:	5.25

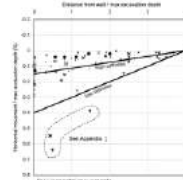
Fig 2.11

Neighbouring Property 1		No. 23 Merton Lane Wa	Interval	4.30
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth		
	A	0.00	0.00	
	B	4.30	2.87	
	D	8.60	5.73	
	E	12.90	8.60	
	F	17.20	11.47	
<b>Horizontal Movement</b>				
Distance (m)	%	(m)	(mm)	
0.00		0.15	0.00225	0.00 Movement at closest wall
4.30		0.04	-0.00064	0.00
8.60		-0.07	-0.00098	0.00
12.90		-0.17	-0.00259	0.00
17.20		-0.28	-0.00420	0.00 Movement at furthest wall
<b>Vertical Movement</b>				
Distance (m)	%	(m)	(mm)	
0.00		0.04	0.00060	7.65 Movement at closest wall
4.30		0.02	-0.00027	5.30
8.60		-0.06	-0.00096	2.30
12.90		-0.15	-0.00219	0.70
17.20		-0.23	-0.00342	0.0045 Movement at furthest wall

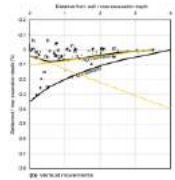
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



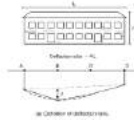
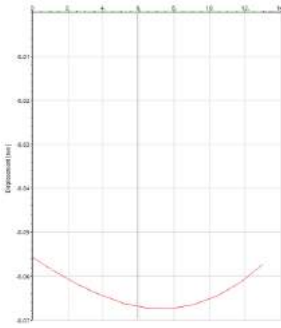
Normalised settlements due to excavation in soft to firm clay



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



**Potential Damage to Building**



Neighbouring Property 1      No. 23 Merton Lane Wall 3

L	m	mm
H	17.20	17200
	6.39	6390
L/H	2.69	

Vertical Deflection (Δ)	0.12 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000698 %	
Horizontal Movement (δh)	0.00 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (Eh) = δh/L	0.00000 %	

**CATEGORY OF DAMAGE**      Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

L/H	2.69
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
(Δ/L)/(Elim)	0.013953488
(Eh)/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>
(Δ/L)/(Elim)	0.009302326
(Eh)/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>
(Δ/L)/(Elim)	0.004651163
(Eh)/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>
(Δ/L)/(Elim)	0.002325581
(Eh)/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'	

Calculated Category of Damage      Negligible

L/H	0.00
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
(Δ/L)/(Elim)	0
(Eh)/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>
(Δ/L)/(Elim)	0
(Eh)/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>
(Δ/L)/(Elim)	0
(Eh)/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>
(Δ/L)/(Elim)	0
(Eh)/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'	

Calculated Category of Damage      Negligible

Fig 2.18 (b)

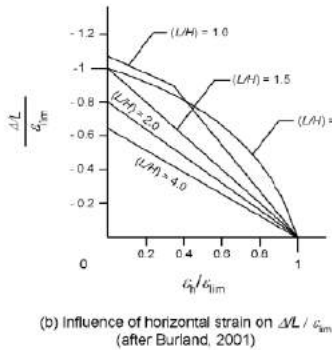


Table 2.5

Table 2.5      Classification of visible damage to walls (after Burland et al, 1977; Vincennes and Gording, 1986 and Dolson, 2001)

Category of damage	Description of typical damage (note of repair is indicated)	Approximate crack width (mm)	Limiting crack width (mm)
0	Negligible: Multiple cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1	Very slight: Fine cracks that can easily be sealed during annual maintenance. The loss is not light fixtures in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2	Slight: Cracks that are visible. Repairs are usually required. Several slight fissures along joints of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows stay close slightly.	< 3	0.075-0.15
3	Moderate: The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4	Severe: Extensive cracks with spalling breaking out and structural members of walls, especially lintels, sills and gables. Windows and frames distorted. Some spalling internally. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but may depend on number of cracks > 1	> 0.3
5	Very severe: This requires a major repair involving partial or complete rebuilding. Doors are distorted, walls are badly and require chinking. Windows broken or with distortion. Degree of instability.	usually > 25	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWR2950  
 Site: 25 West Hill Park  
 Excavation Depth: 1.5

Neighbouring Property 1		Neighbouring Property 2	
House No.	25 Merton Lane Wall 1	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	12.20	Length (m)	
Furthest Wall (m)	12.20	Furthest Wall (m)	
Height	6.39	Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

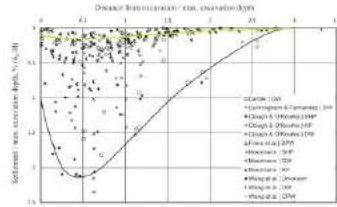
**Distance to Negligible Movement (m)**

Horizontal:	6
Vertical:	5.25

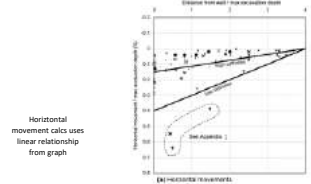
Fig 2.11

Neighbouring Property 1	No. 25 Merton Lane Wa	Interval	3.05
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth	
A	0.00	0.00	
B	3.05	2.03	
D	6.10	4.07	
E	9.15	6.10	
F	12.20	8.13	
<b>Horizontal Movement</b>			
Distance (m)	%	(m)	(mm)
0.00		0.15	0.00225
3.05		0.07	0.00111
6.10		0.00	0.00000
9.15		-0.08	0.00000
12.20		-0.16	0.00000
			<b>0.00</b> Movement at furthest wall
<b>Vertical Movement</b>			
Distance (m)	%	(m)	(mm)
0.00		0.04	0.00060
3.05		0.04	0.00063
6.10		-0.02	-0.00024
9.15		-0.07	-0.00112
12.20		-0.13	-0.00199
			<b>0.0000</b> Movement at furthest wall

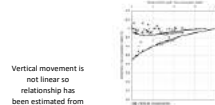
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



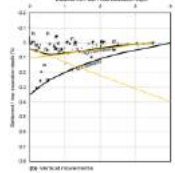
Normalised settlements due to excavation in soft to firm clay



Horizontal movement calls using linear relationship from graph



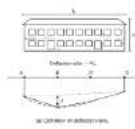
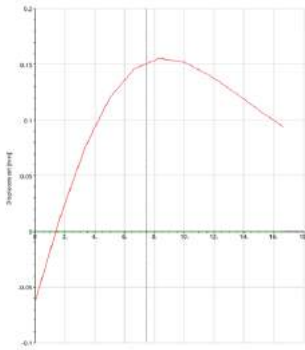
Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



**Potential Damage to Building**



Neighbouring Property 1 No. 25 Merton Lane Wall 1

	m	mm
L	12.20	12200
H	6.39	6390
L/H	1.91	

Vertical Deflection ( $\Delta$ )	0.131 mm	from graph (max difference between blue and orange line)
Deflection Ratio ( $\Delta/L$ )	0.001074 %	
Horizontal Movement ( $\delta_h$ )	0.00 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ( $\epsilon_h = \delta_h/L$ )	0.00000 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2** - can be used to confirm category or is useful if L/H for property is between the given L/H graphs

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

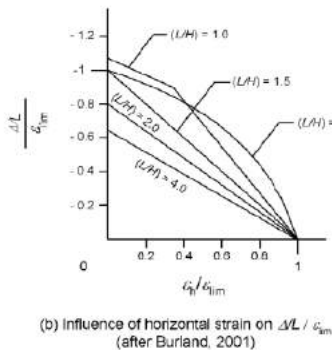
L/H	1.91
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
( $\Delta/L$ )/(Elim)	0.02147541
( $\epsilon_h$ )/(Elim)	0
Very Slight damage limit (Elim)	0.075
( $\Delta/L$ )/(Elim)	0.01431694
( $\epsilon_h$ )/(Elim)	0
Slight damage limit (Elim)	0.15
( $\Delta/L$ )/(Elim)	0.00715847
( $\epsilon_h$ )/(Elim)	0
Moderate damage limit (Elim)	0.3
( $\Delta/L$ )/(Elim)	0.003579235
( $\epsilon_h$ )/(Elim)	0

Calculated Category of Damage Negligible

L/H	0.00
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
( $\Delta/L$ )/(Elim)	0
( $\epsilon_h$ )/(Elim)	0
Very Slight damage limit (Elim)	0.075
( $\Delta/L$ )/(Elim)	0
( $\epsilon_h$ )/(Elim)	0
Slight damage limit (Elim)	0.15
( $\Delta/L$ )/(Elim)	0
( $\epsilon_h$ )/(Elim)	0
Moderate damage limit (Elim)	0.3
( $\Delta/L$ )/(Elim)	0
( $\epsilon_h$ )/(Elim)	0

Calculated Category of Damage Negligible

Fig 2.18 (b)



(b) Influence of horizontal strain on  $\Delta L / L$  (after Burland, 2001)

Table 2.5

Category of damage	Description of typical damage (note of repair is indicated)	Approximate crack width (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during annual maintenance. The less visible light fractures in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks small enough to require occasional repair. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with serious breaking-out and spalling of concrete. Cracks are visible internally. Windows and frames distorted. Door opening irregularly. Walls leaning or bulging noticeably. Some loss of bearing in beams. Service pipes damaged.	15-25 but may exceed 50	> 0.3
5 Very severe	The structure is in a state of serious structural distress. Cracks are visible internally. Windows broken. Doors do not close. Degree of instability.	> 25	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWR2950  
 Site: 25 West Hill Park  
 Excavation Depth: 1.5

Neighbouring Property 1		Neighbouring Property 2	
House No.	25 Merton Lane (Wall 2)	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	20.50	Length (m)	
Furthest Wall (m)	20.50	Furthest Wall (m)	
Height		Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

**Distance to Negligible Movement (m)**

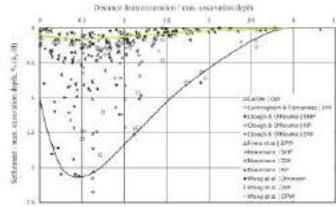
Horizontal:	6
Vertical:	5.25

Fig 2.11

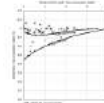
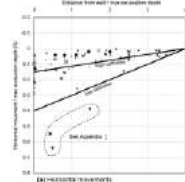
Neighbouring Property 1		No. 25 Merton Lane (W)	Interval	5.13
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth		
	A	0.00	0.00	
	B	5.13	3.42	
	D	10.25	6.83	
	E	15.38	10.25	
	F	20.50	13.67	
Distance (m)	%	<b>Horizontal Movement (mm)</b>		
	0.00	0.15	0.00232	0.00 Movement at closest wall
	5.13	0.02	0.00033	0.00
	10.25	-0.11	-0.00159	0.00
	15.38	-0.23	-0.00000	0.00
20.50	-0.36	-0.00000	0.00 Movement at furthest wall	
Distance (m)	%	<b>Vertical Movement (mm)</b>		
	0.00	0.04	0.00060	7.65 Movement at closest wall
	5.13	0.00	0.00000	5.30
	10.25	-0.10	-0.00143	2.30
	15.38	-0.19	-0.00290	0.70
20.50	-0.29	-0.00436	0.0405 Movement at furthest wall	

NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)

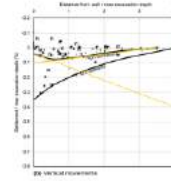
Distance (m)		%	(m)	Vertical Movement (mm)	
0.00	0.04	0.00060	0.60	Movement at closest wall	
5.13	0.00	0.00000	0.60		
10.25	-0.10	-0.00143	0.60		
15.38	-0.19	-0.00290	0.60		
20.50	-0.29	-0.00436	0.60	Movement at furthest wall	



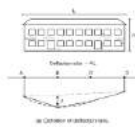
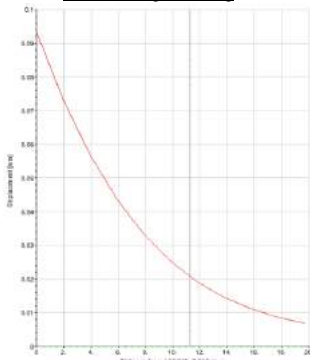
Normalised settlements due to excavation in soft to firm clay



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



**Potential Damage to Building**



Neighbouring Property 1 No. 25 Merton Lane (Wall 2)

	m	mm
L	20.50	20500
H	0.00	0
L/H	#DIV/0!	

Vertical Deflection ( $\Delta$ )	0.02 mm	from graph (max difference between blue and orange line)
Deflection Ratio ( $\Delta/L$ )	0.000098 %	
Horizontal Movement ( $\delta_h$ )	0.00 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ( $\epsilon_h$ ) = $\delta_h/L$	0.00000 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

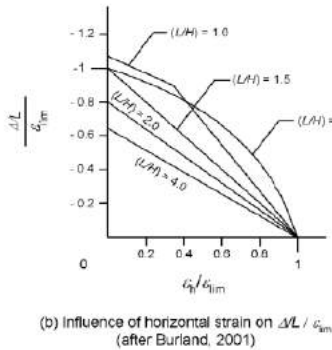
L/H	#DIV/0!	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0.00195122	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0.001300813	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0.000650407	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0.000325203	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $\epsilon_h$ )/(Elim)	0	

Calculated Category of Damage Negligible

L/H	0.00	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $\epsilon_h$ )/(Elim)	0	

Calculated Category of Damage Negligible

Fig 2.18 (b)



(b) Influence of horizontal strain on  $\Delta/L / \epsilon_{lim}$  (after Burland, 2001)

Table 2.5

Classification of visible damage to walls (after Burland et al, 1977; Uncles and Goring, 1988 and Dolan, 2001)

Category of damage	Description of typical damage (note of repair or treatment)	Approximate crack width (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during annual maintenance. The less visible slight fractures in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks small enough to require regular repointing. Several slight fractures around joints of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows stay close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with serious breaking-out and spalling of mortar. Repointing may be necessary. Doors and windows do not close properly. Some serious cracking. Walls leaning or bulging noticeably. Some loss of bearing in beams. Service pipes damaged.	15-25 but may depend on number of cracks > 1	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Doors are seriously out of square and require closing. Windows broken. Walls leaning. Degree of instability.	usually > 25	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWR2950  
 Site: 25 West Hill Park  
 Excavation Depth: 1.5

Neighbouring Property 1		Neighbouring Property 2	
House No.	25 Merton Lane (Wall 3)	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	16.20	Length (m)	
Furthest Wall (m)	16.20	Furthest Wall (m)	
Height	6.39	Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

**Distance to Negligible Movement (m)**

Horizontal:	6
Vertical:	5.25

Fig 2.11

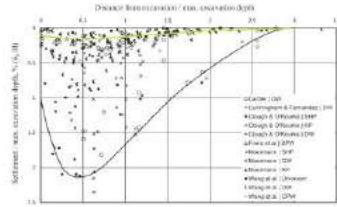
Neighbouring Property 1 No. 25 Merton Lane (W) Interval 4.05

Contour Plot Point	Distance (m)	Distance/Max Excavation Depth	
		Distance	Max Excavation Depth
A	0.00	0.00	0.00
B	4.05	2.70	1.80
D	8.10	5.40	3.60
E	12.15	8.10	5.40
F	16.20	10.80	7.20

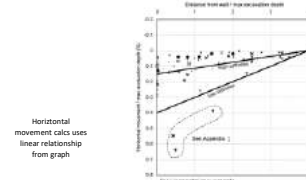
Distance (m)	%	Horizontal Movement (mm)	
		Distance (m)	Horizontal Movement (mm)
0.00	0.15	0.00	0.00
4.05	0.05	0.00	0.00
8.10	-0.05	0.00	0.00
12.15	-0.15	0.00	0.00
16.20	-0.26	0.00	0.00

Distance (m)	%	Vertical Movement (mm)	
		Distance (m)	Vertical Movement (mm)
0.00	0.04	0.00060	7.65
4.05	0.02	-0.00034	5.30
8.10	-0.05	-0.00082	2.30
12.15	-0.13	-0.00197	0.70
16.20	-0.21	-0.00315	0.0045

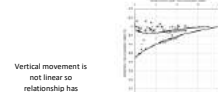
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



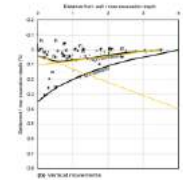
Normalised settlements due to excavation in soft to firm clay



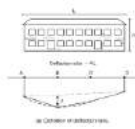
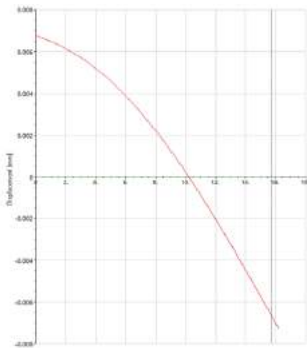
Horizontal movement calls uses linear relationship from graph



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



**Potential Damage to Building**



Neighbouring Property 1 No. 25 Merton Lane (Wall 3)

L	m	mm
H	16.20	16200
	6.39	6390
L/H	2.54	

Vertical Deflection (Δ)	0.0022 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.00014 %	
Horizontal Movement (δh)	0.00 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (εh) = δh/L	0.00000 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

L/H	2.54
Negligible damage limit (Elim)	0.05
(Δ/L)/(Elim)	0.000271605
(εh)/(Elim)	0
Very Slight damage limit (Elim)	0.075
(Δ/L)/(Elim)	0.00018107
(εh)/(Elim)	0
Slight damage limit (Elim)	0.15
(Δ/L)/(Elim)	9.0535E-05
(εh)/(Elim)	0
Moderate damage limit (Elim)	0.3
(Δ/L)/(Elim)	4.52675E-05
(εh)/(Elim)	0

Calculated Category of Damage Negligible

L/H	0.00
Negligible damage limit (Elim)	0.05
(Δ/L)/(Elim)	0
(εh)/(Elim)	0
Very Slight damage limit (Elim)	0.075
(Δ/L)/(Elim)	0
(εh)/(Elim)	0
Slight damage limit (Elim)	0.15
(Δ/L)/(Elim)	0
(εh)/(Elim)	0
Moderate damage limit (Elim)	0.3
(Δ/L)/(Elim)	0
(εh)/(Elim)	0

Calculated Category of Damage Negligible

Fig 2.18 (b)

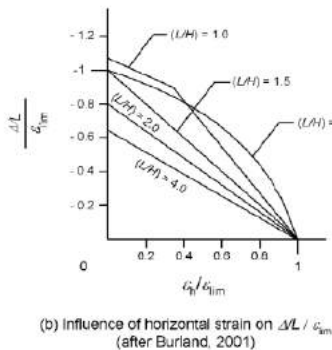


Table 2.5

Table 2.5 Classification of visible damage to walls (after Burland et al, 1977; Woodcock and Gording, 1986 and Dolan, 2001)

Category of damage	Description of typical damage (note of repair is indicated)	Approximate crack width (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during annual maintenance. The less visible light fractures in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks small enough to be repaired with a single application of repair mortar. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with serious breaking-out and spalling of mortar. Repointing of mortar joints and windows. Windows and frames distorted. Some stopping internally. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but may depend on number of cracks > 1	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Doors and windows may not close and require closing. Windows broken. Walls leaning. Degree of instability.	> 25	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWPR2950  
Site: 26 West Hill Park

Excavation Depth: 1.5

**Neighbouring Property 1**

House No.	25 Merton Lane (Wall 4)	
Closest Wall (m)	0.00	
Length (m)	15.80	
Furthest Wall (m)	15.80	
Height	6.39	

**Neighbouring Property 2**

House No.		
Closest Wall (m)		
Length (m)		
Furthest Wall (m)		
Height		

Ground Movement Due to Excavation - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

<b>Distance to Negligible Movement</b>	
Horizontal: (m)	6
Vertical: (m)	5.25

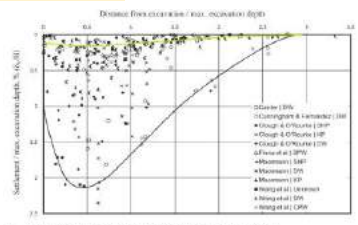
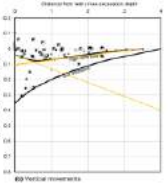
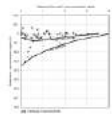
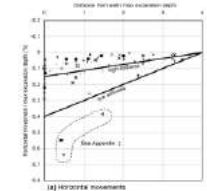
Fig 2.11

Neighbouring Property 1		No. 25 Merton Lane (Wz)	Interval	3.95	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth			
	A	0.00			
	B	3.95	2.63		
	D	7.90	5.27		
	E	11.85	7.90		
	F	15.80	10.53		
Distance (m)	%	Horizontal Movement (mm)			
	0.00	0.15	0.00	Movement at closest wall	
	3.95	0.05	0.00		
	7.90	-0.05	0.00		
	11.85	-0.15	0.00		
	15.80	-0.25	0.00	Movement at furthest wall	
Distance (m)	%	Vertical Movement (mm)			
	0.00	0.04	0.00060	7.65	Movement at closest wall
	3.95	0.02	0.00037	5.36	
	7.90	-0.05	-0.00076	3.30	
	11.85	-0.13	-0.00189	0.70	
	15.80	-0.20	-0.00302	0.0045	Movement at furthest wall

NOTE: if there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)

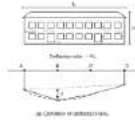
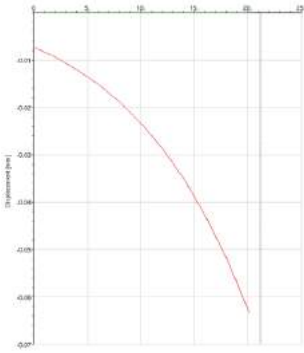
Horizontal movement calcs uses linear relationship from graph

Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



(d) Normalised settlements due to excavation in soft to firm clay

**Potential Damage to Building**



Neighbouring Property 1 No. 25 Merton Lane (Wall 4)

L	m	mm
H	15.80	15800
	6.39	6390
L/H	2.47	

Vertical Deflection (Δ)	0.01 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.00063 %	
Horizontal Movement (δh)	0.00 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (εh) = δh/L	0.00000 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

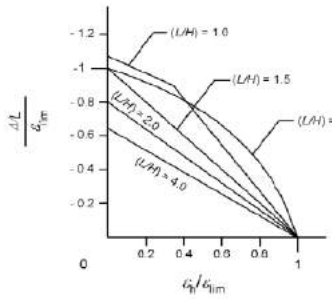
L/H	2.47
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
(Δ/L)/(Elim)	0.001265823
(εh)/(Elim)	0
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>
(Δ/L)/(Elim)	0.000843882
(εh)/(Elim)	0
<b>Slight damage limit (Elim)</b>	<b>0.15</b>
(Δ/L)/(Elim)	0.000421941
(εh)/(Elim)	0
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>
(Δ/L)/(Elim)	0.00021097
(εh)/(Elim)	0

Calculated Category of Damage **Negligible**

L/H	0.00
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
(Δ/L)/(Elim)	0
(εh)/(Elim)	0
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>
(Δ/L)/(Elim)	0
(εh)/(Elim)	0
<b>Slight damage limit (Elim)</b>	<b>0.15</b>
(Δ/L)/(Elim)	0
(εh)/(Elim)	0
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>
(Δ/L)/(Elim)	0
(εh)/(Elim)	0

Calculated Category of Damage **Negligible**

Fig 2.18 (b)



(b) Influence of horizontal strain on  $\Delta L / c_{lim}$  (after Burland, 2001)

Table 2.5

Classification of visible damage to walls (after Burland et al, 1997; Eurocode and Corning, 1988 and Corning, 2001)

Category of damage	Description of typical damage (note of repair is indicated)	Approximate crack width (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible	< 0.1	0.1-0.01
1 Very slight	Fine cracks that can easily be sealed during annual maintenance. The less visible light fractures in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks that are visible. Repairs are usually required. Several slight fractures around joints of building. Cracks are visible externally and some repainting may be required externally to ensure weather-tightness. Doors and windows may close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repainting of external brickwork and possibly a small amount of plaster to be applied. Doors and windows do not close. Service pipes may fracture. Water/gas pipes often repaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with serious breaking-out and spalling of concrete. Repairs are extensive. Doors and windows. Windows and frames distorted. Some stopping internally. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but one depends on number of cracks > 1	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Doors are seriously distorted and require closing. Windows broken. Walls leaning. Degree of instability.	usually > 25	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWR2950  
 Site: 26 West Hill Park  
 Excavation Depth: 7.5

Neighbouring Property 1		Neighbouring Property 2	
House No.	Western Wall 25 West Park Hill (Wall 1)	House No.	
Closest Wall (m)	2.90	Closest Wall (m)	
Length (m)	12.30	Length (m)	
Furthest Wall (m)	15.20	Furthest Wall (m)	
Height	8.36	Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

**Distance to Negligible Movement (m)**

Horizontal:	30
Vertical:	26.25

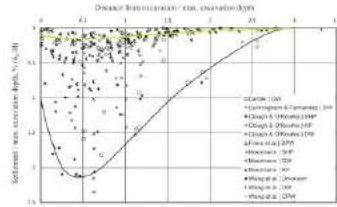
Fig 2.11

Neighbouring Property 1	No. Western Wall 25 Wt	Interval	3.08	Distance/Max Excavation Depth	
				Distance (m)	Excavation Depth
Contour Plot Point					
A	2.90			0.39	
B	5.98			0.80	
D	9.05			1.21	
E	12.13			1.62	
F	15.20			2.03	

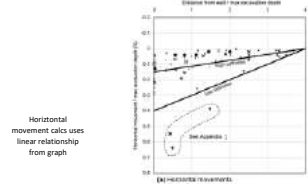
  

Distance (m)	%	(m)	Horizontal Movement (mm)	
2.90	0.14	0.01016	18.15	Movement at closest wall
5.98	0.12	0.00901	3.03	
9.05	0.10	0.00786	7.86	
12.13	0.09	0.00670	6.70	
15.20	0.07	0.00555	5.55	Movement at furthest wall

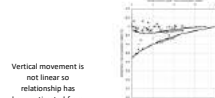
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



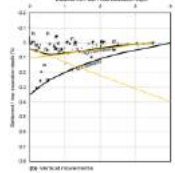
Normalised settlements due to excavation in soft to firm clay



Horizontal movement calcs uses linear relationship from graph



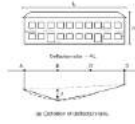
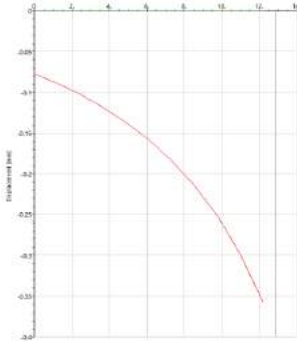
Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



**Potential Damage to Building**



Neighbouring Property 1 No. Western Wall 25 West Park Hill (Wall 1)

	m	mm
L	12.30	12300
H	8.36	8360
L/H	1.47	

Vertical Deflection (Δ)	0.05 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000407 %	
Horizontal Movement (δh)	4.61 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (εh) = δh/L	0.03750 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

L/H	1.47	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
(Δ/L)/(Elim)	0.008130081	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(εh)/(Elim)	0.75	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
(Δ/L)/(Elim)	0.005420054	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(εh)/(Elim)	0.5	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
(Δ/L)/(Elim)	0.002710027	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(εh)/(Elim)	0.25	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
(Δ/L)/(Elim)	0.001355014	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(εh)/(Elim)	0.125	

Calculated Category of Damage Negligible

L/H	0.00	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(εh)/(Elim)	0	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(εh)/(Elim)	0	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(εh)/(Elim)	0	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(εh)/(Elim)	0	

Calculated Category of Damage Negligible

Fig 2.18 (b)

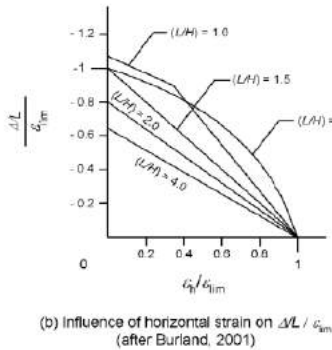


Table 2.5

Category of damage	Description of typical damage (note or repair as indicated)	Approximate crack widths (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during annual maintenance. The lines indicate slight fracture in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks small enough to require occasional repair. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows stay shut slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with serious breaking-out and spalling of concrete. Cracks are visible internally. Windows and frames distorted. Door opening inoperable. Walls leaning or bulging noticeably. Some loss of bearing in beams. Service pipes damaged.	15-25 but may be more	> 0.3
5 Very severe	The structure is in a state of serious partial or complete collapse. Doors and windows will not close. Windows broken. Degree of instability.	> 25	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWR2950  
 Site: 26 West Hill Park  
 Excavation Depth: 5

Neighbouring Property 1		Neighbouring Property 2	
House No.	Western Wall 25 West Park Hill (Wall 1)	House No.	
Closest Wall (m)	2.90	Closest Wall (m)	
Length (m)	12.30	Length (m)	
Furthest Wall (m)	15.20	Furthest Wall (m)	
Height	8.36	Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

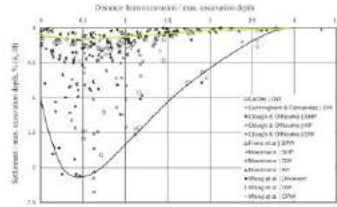
**Distance to Negligible Movement**

Horizontal:	20
Vertical:	17.5

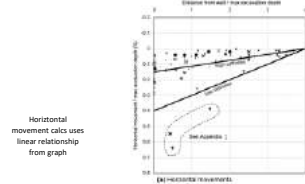
Fig 2.11

Contour Plot Point	Distance (m)	Distance/Max Excavation Depth		Horizontal Movement (mm)	Movement
		No. Western Wall 25 Wt	Interval		
A	2.90	0.58	3.08	6.41	Movement at closest wall
B	5.98	1.20		3.26	
D	9.05	1.81		4.11	
E	12.13	2.43		2.95	
F	15.20	3.04		1.80	Movement at furthest wall

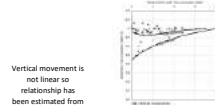
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



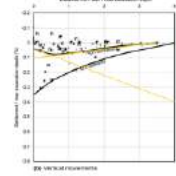
Normalised settlements due to excavation in soft to firm clay



Horizontal movement calcs uses linear relationship from graph

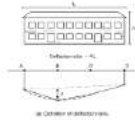
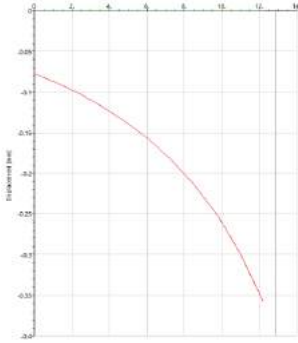


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.

**Potential Damage to Building**



Neighbouring Property 1 No. Western Wall 25 West Park Hill (Wall 1)

	m	mm
L	12.30	12300
H	8.36	8360
L/H	1.47	

Vertical Deflection ( $\Delta$ )	0.05 mm	from graph (max difference between blue and orange line)
Deflection Ratio ( $\Delta/L$ )	0.000407 %	
Horizontal Movement ( $\delta_h$ )	4.61 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ( $\epsilon_h = \delta_h/L$ )	0.03750 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

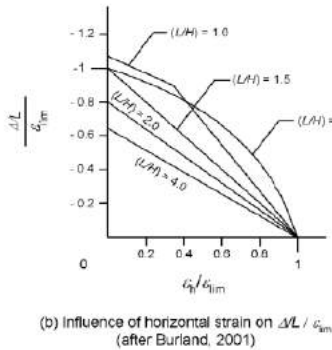
L/H	1.47	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0.008130081	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0.75	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0.005420054	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0.5	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0.002710027	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0.25	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0.001355014	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $\epsilon_h$ )/(Elim)	0.125	

Calculated Category of Damage Negligible

L/H	0.00	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $\epsilon_h$ )/(Elim)	0	

Calculated Category of Damage Negligible

Fig 2.18 (b)



(b) Influence of horizontal strain on  $\Delta/L / \epsilon_{lim}$  (after Burland, 2001)

Table 2.5

Category of damage	Description of typical damage (type or repair as indicated)	Approximate crack width (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during normal decoration. The lines indicate slight fracture in loading. Cracks are external but visible under inspection.	< 1	0.05-0.075
2 Slight	Cracks that are visible and can be repaired by surface treatment. Cracks are visible externally and some repair may be required externally to ensure weathertightness. Doors and windows may close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Depending on external finish and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or more	0.15-0.3
4 Severe	Extensive cracks with serious breaking-out and spalling of concrete. Cracks are visible and can be sealed by a mortar. External cracks can be sealed by suitable means. Depending on external finish and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture.	15-25 or more	0.3
5 Very severe	The structure is in danger of partial or complete collapse. Doors and windows may not close and require closing. Windows broken. Doors and windows may not close. Degree of instability.	> 25	> 0.3

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWP2950  
 Site: 25 West Hill Park  
 Excavation Depth: 7.5

Neighbouring Property 1		Neighbouring Property 2	
House No.	25 West Park Hill (Wall 2)		
Closest Wall (m)	0.00		
Length (m)	13.40		
Farthest Wall (m)	13.40		
Height	8.36		

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

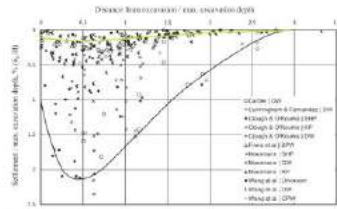
(Table 2.4 CIRIA C760)

Distance to Negligible Movement (m)	
Horizontal:	30
Vertical:	26.25

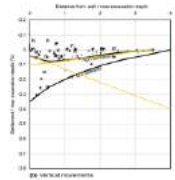
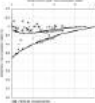
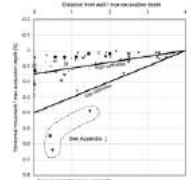
Fig 2.11

Neighbouring Property 1		No. 25 West Park Hill (A)		Interval		3.35	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth					
	A	0.00	0.00				
	B	3.35	0.45				
	D	6.70	0.89				
	E	10.05	1.34				
	F	13.40	1.79				
		Horizontal Movement					
Distance (m)	%	(m)	(mm)				
0.00		0.15		7.69 Movement at closest wall			
3.35		0.13					
6.70		0.12					
10.05		0.10					
13.40		0.08		3.86 Movement at furthest wall			

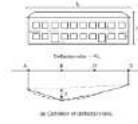
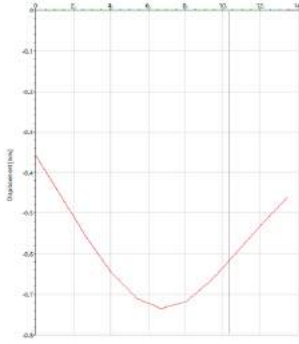
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



Normalised settlements due to excavation in soft to firm clay



**Potential Damage to Building**



Neighbouring Property 1 No. 25 West Park Hill (Wall 2)

	m	mm
L	13.40	13400
H	8.36	8360
L/H	1.60	

Vertical Deflection ( $\Delta$ )	0.39 mm	from graph (max difference between blue and orange line)
Deflection Ratio ( $\Delta/L$ )	0.002910 %	
Horizontal Movement ( $\delta_h$ )	3.83 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ( $\epsilon_h = \delta_h/L$ )	0.02858 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

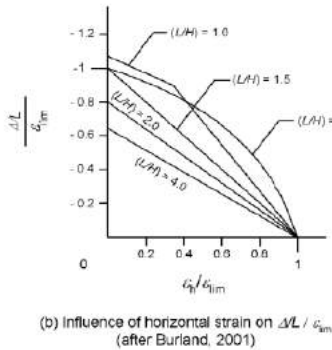
L/H	1.60	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0.058208955	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0.571641791	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0.03880597	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0.381094527	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0.019402985	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0.190547264	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0.009701493	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $\epsilon_h$ )/(Elim)	0.095273632	

Calculated Category of Damage Negligible

L/H	0.00	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $\epsilon_h$ )/(Elim)	0	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $\epsilon_h$ )/(Elim)	0	

Calculated Category of Damage Negligible

Fig 2.18 (b)



(b) Influence of horizontal strain on  $\Delta/L / \epsilon_{lim}$  (after Burland, 2001)

Table 2.5

Category of damage	Description of typical damage (note of repair is indicated)	Approximate crack width (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during normal decoration. The loss is not light fixture or building. Cracks are external but visible under inspection.	< 1	0.05-0.075
2 Slight	Cracks that are visible and can be repaired by surface treatment. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with spalling breaking out and structural members of walls, supports, lintels and sills. Windows and frames distorted. Door closing inoperable. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but may depend on number of cracks > 1	> 0.3
5 Very severe	The structure is in danger of partial or complete collapse. Doors and windows may not close and require closing. Windows broken. Doors in danger of falling. Degree of instability.	usually > 25	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWPR2950  
Site: 26 West Hill Park

Excavation Depth: 5

**Neighbouring Property 1**

House No.	25 West Park Hill Wall 2	
Closest Wall (m)	0.00	
Length (m)	13.40	
Furthest Wall (m)	13.40	
Height	6.36	

**Neighbouring Property 2**

House No.		
Closest Wall (m)		
Length (m)		
Furthest Wall (m)		
Height		

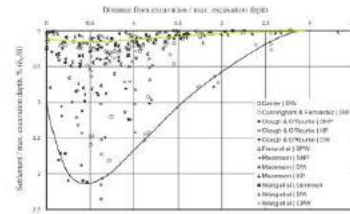
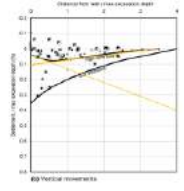
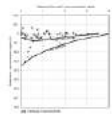
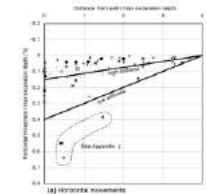
Ground Movement Due to Excavation - Assuming Soft to Firm Clay  
(Table 2.4 CIRIA C760)

<b>Distance to Negligible Movement (m)</b>	
Horizontal:	20
Vertical:	17.5

Fig 2.11

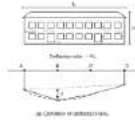
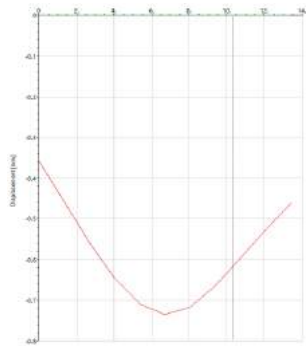
<b>Neighbouring Property 1</b>		No. 25 West Park Hill W:	Interval	3.35	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth			
	A	0.00			
	B	3.35	0.67		
	D	6.70	1.34		
	E	10.05	2.01		
	F	13.40	2.68		
Distance (m)	%	<b>Horizontal Movement (mm)</b>			
	0.00	0.15	0.00750	6.11 Movement at closest wall	
	3.35	0.12			
	6.70	0.10			
	10.05	0.07			
	13.40	0.05	0.00248	5.85 Movement at furthest wall	

NOTE: if there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



(d) Normalised settlements due to excavation in soft to firm clay

**Potential Damage to Building**



Neighbouring Property 1

No. 25 West Park Hill Wall 2

	m	mm
L	13.40	13400
H	8.36	8360
L/H	1.60	

Vertical Deflection (Δ)	0.39 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.002910 %	
Horizontal Movement (δh)	0.26 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (εh) = δh/L	0.00194 %	

**CATEGORY OF DAMAGE**

Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

L/H	1.60	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
(Δ/L)/(Elim)	0.058208955	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(εh)/(Elim)	0.03880597	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
(Δ/L)/(Elim)	0.03880597	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(εh)/(Elim)	0.025870647	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
(Δ/L)/(Elim)	0.019402985	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(εh)/(Elim)	0.012935323	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
(Δ/L)/(Elim)	0.009701493	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(εh)/(Elim)	0.006467662	

Calculated Category of Damage

Negligible

L/H	0.00	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(εh)/(Elim)	0	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(εh)/(Elim)	0	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(εh)/(Elim)	0	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(εh)/(Elim)	0	

Calculated Category of Damage

Negligible

Fig 2.18 (b)

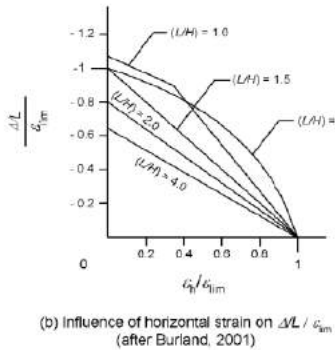


Table 2.5

Category of damage	Description of typical damage (note or repair as indicated)	Approximate crack width (mm)	Limiting crack width (mm)
0 Negligible	Minute cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during normal decoration. The less visible light fractures in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks small enough to require occasional repainting. Several slight fractures around joints of building. Cracks are visible externally and some repainting may be required externally to ensure weathertightness. Doors and windows stay shut slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mason. External cracks can be sealed by suitable means. Repainting of external brickwork and possibly a small amount of plaster to be applied. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with cracking breaking out and spalling sections of walls, especially over doors and windows. Windows and frames distorted. Door staying inoperative. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but may depend on number of cracks > 1	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Doors are inoperative, walls bow badly and require shoring. Windows broken, or no number of wall sections. Degree of instability.	usually > 25	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWP2950  
 Site: 25 West Hill Park  
 Excavation Depth: 5

Neighbouring Property 1		Neighbouring Property 2	
House No.	25 West Park Hill (Wall 3)	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	13.00	Length (m)	
Furthest Wall (m)	13.00	Furthest Wall (m)	
Height	8.36	Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

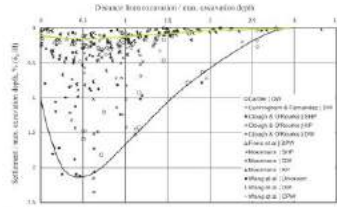
**Distance to Negligible Movement**

Horizontal: (m)	20
Vertical: (m)	17.5

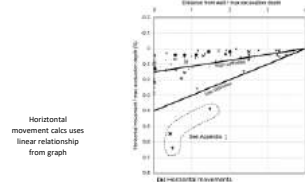
Fig 2.11

Neighbouring Property 1		No. 25 West Park Hill (A)		Interval		3.25	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth					
	A	0.00	0.00				
	B	3.25	0.65				
	D	6.50	1.30				
	E	9.75	1.95				
F	13.00	2.60					
Distance (m)	%	Horizontal Movement (mm)					
	0.00	0.15	1.73		Movement at closest wall		
	3.25	0.13					
	6.50	0.10					
	9.75	0.08					
13.00	0.05	0.00		Movement at furthest wall			

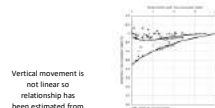
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



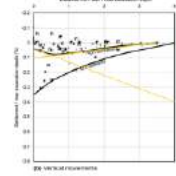
Normalised settlements due to excavation in soft to firm clay



Horizontal movement calls uses linear relationship from graph

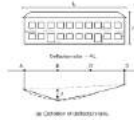
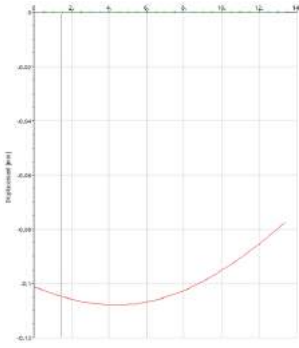


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.





**Potential Damage to Building**



Neighbouring Property 1 No. 25 West Park Hill (Wall 3)

	m	mm
L	13.00	13000
H	8.36	8360
L/H	1.56	

Vertical Deflection (Δ)	0.012 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.00092 %	
Horizontal Movement (δh)	1.73 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (Eh) = δh/L	0.01331 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

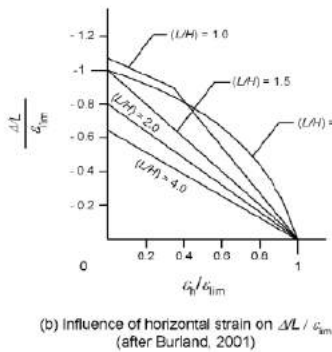
L/H	1.56	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
(Δ/L)/(Elim)	0.001846154	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(Eh)/(Elim)	0.266153846	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
(Δ/L)/(Elim)	0.001230769	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(Eh)/(Elim)	0.177455897	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
(Δ/L)/(Elim)	0.000615385	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(Eh)/(Elim)	0.088717949	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
(Δ/L)/(Elim)	0.000307692	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(Eh)/(Elim)	0.044358974	

Calculated Category of Damage Negligible

L/H	0.00	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(Eh)/(Elim)	0	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(Eh)/(Elim)	0	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(Eh)/(Elim)	0	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
(Δ/L)/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(Eh)/(Elim)	0	

Calculated Category of Damage Negligible

Fig 2.18 (b)



(b) Influence of horizontal strain on ΔL / c<sub>lim</sub> (after Burland, 2001)

Table 2.5

Category of damage	Description of typical damage (note of repair is indicated)	Approximate crack width (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during annual maintenance. The loss is not light fracture in loading. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks that are visible and can be repaired during annual maintenance. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with cracking breaking out and spalling of concrete. Cracks are visible internally. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	15-25 or a number of cracks > 3	> 0.3
5 Very severe	The structure is in danger of partial or complete collapse. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	> 25 or a number of cracks > 5	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWP2950  
 Site: 25 West Hill Park  
 Excavation Depth: 7.5

Neighbouring Property 1		Neighbouring Property 2	
House No.	25 West Park Hill (Wall 3)	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	13.00	Length (m)	
Furthest Wall (m)	13.00	Furthest Wall (m)	
Height	8.36	Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

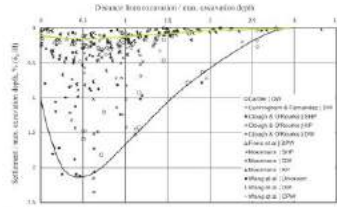
**Distance to Negligible Movement**

Direction	Distance (m)
Horizontal	30
Vertical	26.25

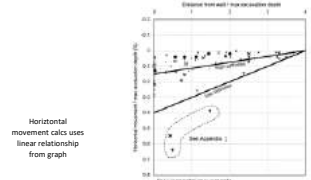
Fig 2.11

Neighbouring Property 1		No. 25 West Park Hill (N)		Interval		3.25	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth					
	A	0.00	0.00				
	B	3.25	0.43				
	D	6.50	0.87				
E	9.75	1.30					
	F	13.00	1.73				
Distance (m)		%	(m)	Horizontal Movement (mm)			
0.00			0.15	3.45		Movement at closest wall	
3.25			0.13				
6.50			0.12				
9.75			0.10				
13.00			0.09	1.50		Movement at furthest wall	

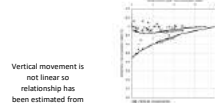
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



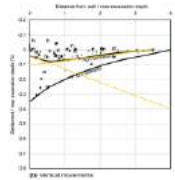
Normalised settlements due to excavation in soft to firm clay



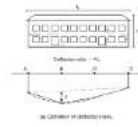
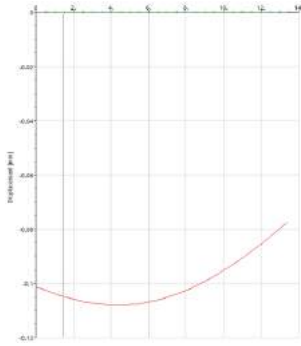
Horizontal movement calls uses linear relationship from graph



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



**Potential Damage to Building**



Neighbouring Property 1 No. 25 West Park Hill (Wall 3)

	m	mm
L	13.00	13000
H	8.36	8360
L/H	1.56	

Vertical Deflection ( $\Delta$ )	0.012 mm	from graph (max difference between blue and orange line)
Deflection Ratio ( $\Delta/L$ )	0.00092 %	
Horizontal Movement ( $\delta h$ )	1.95 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ( $E_h$ ) = $\delta h/L$	0.01500 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

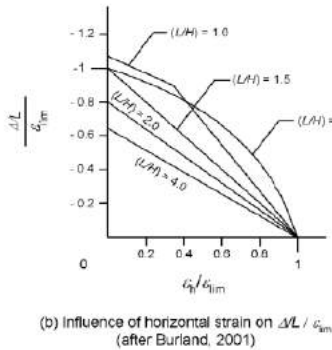
L/H	1.56	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0.01846154	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $E_h$ )/(Elim)	0.3	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0.001230769	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $E_h$ )/(Elim)	0.2	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0.000615385	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $E_h$ )/(Elim)	0.1	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0.000307692	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $E_h$ )/(Elim)	0.05	

Calculated Category of Damage Negligible

L/H	0.00	
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
( $E_h$ )/(Elim)	0	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
( $E_h$ )/(Elim)	0	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
( $E_h$ )/(Elim)	0	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>	
( $\Delta/L$ )/(Elim)	0	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
( $E_h$ )/(Elim)	0	

Calculated Category of Damage Negligible

Fig 2.18 (b)



(b) Influence of horizontal strain on  $\Delta/L / E_h$  (after Burland, 2001)

Table 2.5

Category of damage	Description of typical damage (note or repair as indicated)	Approximate crack widths (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during normal decoration. The less visible, slight fractures in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks small, blind. Reproduction probably required. Several slight fractures showing signs of leaking. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows stay close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do leak. Service pipes show fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with serious leaking and structural weakness of walls, especially over doors and windows. Windows and frames distorted. Door staying inoperative. Walls leaking or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but may exceed 30	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Doors are inoperative, walls bow badly and require shoring. Windows broken, or less than fully and require shoring. Windows broken, or less than fully and require shoring. Degree of instability.	usually > 25	> 0.5

**Ground Movement Analysis - CIRIA C760 Embedded Retaining Walls (For EXCAVATION ONLY)**

Project Ref: GWR2950  
 Site: 26 West Hill Park  
 Excavation Depth: 5

Neighbouring Property 1		Neighbouring Property 2	
House No.	Western Wall 25 West Park Hill (Wall 4)	House No.	
Closest Wall (m)	3.10	Closest Wall (m)	
Length (m)	12.40	Length (m)	
Farthest Wall (m)	15.50	Farthest Wall (m)	
Height	8.36	Height	

**Ground Movement Due to Excavation - Assuming Soft to Firm Clay**

(Table 2.4 CIRIA C760)

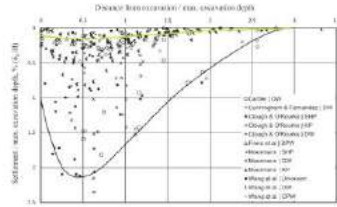
**Distance to Negligible Movement (m)**

Horizontal:	20
Vertical:	17.5

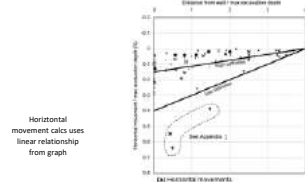
Fig 2.11

Neighbouring Property 1		No. Western Wall 25 Wt	Interval	3.10
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth		
	A	3.10	0.62	
	B	6.20	1.24	
	D	9.30	1.86	
	E	12.40	2.48	
	F	15.50	3.10	
Distance (m)	%	(m)	(mm)	
	3.10	0.13	0.00334	6.34 Movement at closest wall
	6.20	0.10	0.00316	5.18
	9.30	0.08	0.00401	4.01
	12.40	0.06	0.00285	2.85
	15.50	0.03	0.00169	1.69 Movement at furthest wall

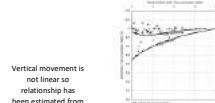
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



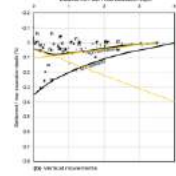
Normalised settlements due to excavation in soft to firm clay



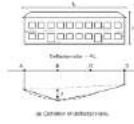
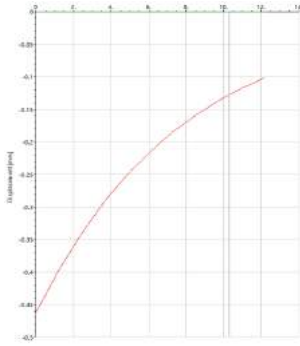
Horizontal movement calcs uses linear relationship from graph



Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



**Potential Damage to Building**



Neighbouring Property 1 No. Western Wall 25 West Park Hill (Wall 4)

	m	mm
L	12.40	12400
H	8.36	8360
L/H	1.48	

Vertical Deflection ( $\Delta$ )	0.08 mm	from graph (max difference between blue and orange line)
Deflection Ratio ( $\Delta/L$ )	0.000645 %	
Horizontal Movement ( $\delta_h$ )	4.65 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ( $E_h$ ) = $\delta_h/L$	0.03750 %	

**CATEGORY OF DAMAGE** Damage category limits are given in Table 2.5 (below).

**Method 1 - Preferred method**

- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of damage

**Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs**

- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

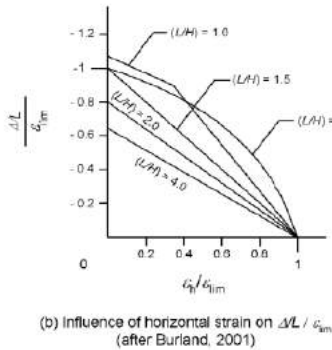
L/H	1.48
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
( $\Delta/L$ )/(Elim)	0.012903226
( $E_h$ )/(Elim)	0.75
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>
( $\Delta/L$ )/(Elim)	0.008602151
( $E_h$ )/(Elim)	0.5
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>
( $\Delta/L$ )/(Elim)	0.004301075
( $E_h$ )/(Elim)	0.25
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>
( $\Delta/L$ )/(Elim)	0.002150538
( $E_h$ )/(Elim)	0.125
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'	

Calculated Category of Damage Negligible

L/H	0.00
<b>Negligible damage limit (Elim)</b>	<b>0.05</b>
( $\Delta/L$ )/(Elim)	0
( $E_h$ )/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below	
<b>Very Slight damage limit (Elim)</b>	<b>0.075</b>
( $\Delta/L$ )/(Elim)	0
( $E_h$ )/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below	
<b>Slight damage limit (Elim)</b>	<b>0.15</b>
( $\Delta/L$ )/(Elim)	0
( $E_h$ )/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below	
<b>Moderate damage limit (Elim)</b>	<b>0.3</b>
( $\Delta/L$ )/(Elim)	0
( $E_h$ )/(Elim)	0
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'	

Calculated Category of Damage Negligible

Fig 2.18 (b)



(b) Influence of horizontal strain on  $\Delta/L / E_{lim}$  (after Burland, 2001)

Table 2.5

Category of damage	Description of typical damage (note or repair as indicated)	Approximate crack widths (mm)	Limiting crack width (mm)
0 Negligible	Multiple cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.04-0.05
1 Very slight	Fine cracks that can easily be sealed during annual maintenance. The less visible light fractures in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks small, blind. Repairs when probably required. Several slight fractures around joints of building. Cracks are visible externally and some repainting may be required externally to ensure weathertightness. Doors and windows stay close slightly.	< 3	0.075-0.15
3 Moderate	The cracks require some opening up and can be sealed by a mortar. External cracks can be sealed by suitable means. Repainting of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weathertightness often impaired.	3-15 or a number of cracks > 1	0.15-0.3
4 Severe	Extensive cracks with cracking breaking out and spalling sections of walls, especially around doors and windows. Windows and frames distorted. Door staying inoperative. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but one depends on number of cracks > 1	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Doors are inoperative, walls bow badly and require shoring. Windows broken. No number of walls shattering. Degree of instability.	usually > 25	> 0.3