

Appendix F
Ground Movement Assessment Calculations (Stage 3)

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		Neighbouring Property 2	
House No.	23 Merton Lane Wall 1	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	14.10	Length (m)	
Furthest Wall (m)	14.10	Furthest Wall (m)	
Height	6.39	Height	

Ground Movement Due to Excavation - Assuming Soft to Firm Clay

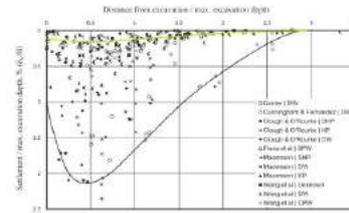
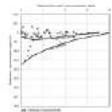
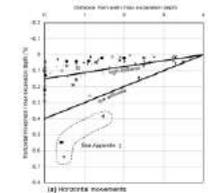
(Table 2.4 CIRIA C760)

Distance to Negligible Movement (m)	
Horizontal:	6
Vertical:	5.25

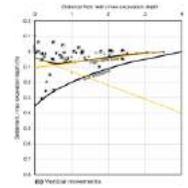
Fig 2.11

Neighbouring Property 1		No. 23 Merton Lane Wall		Interval		3.53	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth					
	A	0.00					
	B	3.53	2.35				
	D	7.05	4.30				
	E	10.58	7.05				
	F	14.10	9.40				
Distance (m)	%	(m)	(mm)				
	0.00	0.15	0.00235	0.38	Movement at closest wall		
	3.53	0.06	0.00093				
	7.05	-0.03	-0.00039				
	10.58	-0.11	-0.00172	0.00	Movement at furthest wall		
	14.10	-0.20	-0.00304				
Distance (m)	%	(m)	(mm)				
	0.00	0.04	7.65	Movement at closest wall			
	3.53	0.03	5.36				
	7.05	-0.03	3.30				
	10.58	-0.10	0.70				
	14.10	-0.17	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)

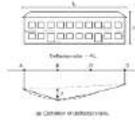
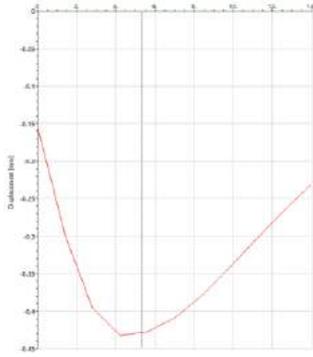


(a) Normalised settlements due to excavation in soft to firm clay



(b) Vertical movements

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 (Δ)	0.255 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.001809 %	
Horizontal Movement (δh)	0.38 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (εh) = δh/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

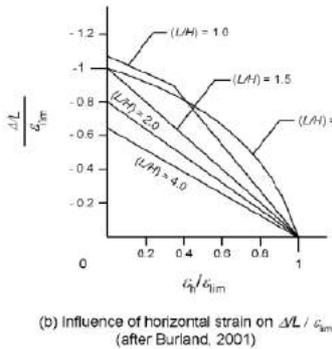
L/H	2.21	
Negligible damage limit (Elim)	0.05	
(Δ/L)/(Elim)	0.036170213	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(εh)/(Elim)	0.053900709	
Very Slight damage limit (Elim)	0.075	
(Δ/L)/(Elim)	0.024113475	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)	0.035933806	
Slight damage limit (Elim)	0.15	
(Δ/L)/(Elim)	0.012056738	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)	0.017966903	
Moderate damage limit (Elim)	0.3	
(Δ/L)/(Elim)	0.006028369	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)	0.008983452	

Calculated Category of Damage Negligible

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



(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 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 inspection. 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. Several slight fractures around joints of loading. 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, supports, lintels and sills. 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	The masonry is in danger of falling out or concrete spalling. Doors are inoperative, walls are badly and require closing. Windows broken. Doors inoperative. 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: 1.5

Neighbouring Property 1

House No.	23 Merton Lane Wall 2	
Closest Wall (m)	0.00	
Length (m)	25.30	
Furthest Wall (m)	25.30	
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

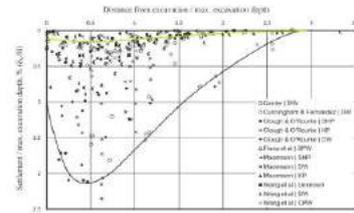
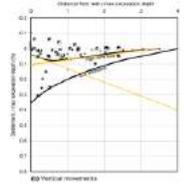
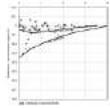
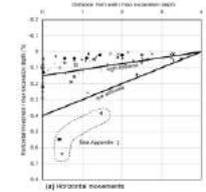
Fig 2.11

Neighbouring Property 1		No. 23 Merton Lane Wall	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)	%	Horizontal Movement			
		(m)	(mm)		
	0.00	0.15	0.00225	0.38 Movement at closest wall	
	6.33	-0.01	-0.00012	0.00	
	12.65	-0.17	-0.00249	0.00	
	18.98	-0.32	-0.00487	0.00	
25.30	-0.48	-0.00724	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)

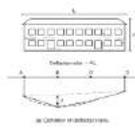
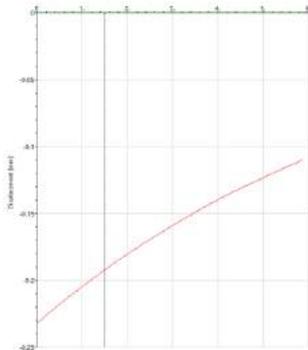
Horizontal movement calcs uses linear relationship from graph

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. 23 Merton Lane Wall 2

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

Vertical Deflection (Δ)	0.01 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.00040 %	
Horizontal Movement (δh)	0.38 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (εh) = 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

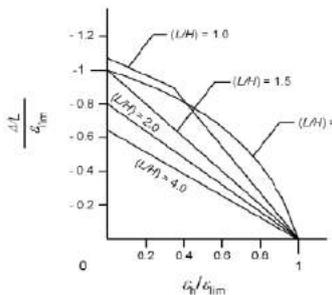
L/H	3.96	
Negligible damage limit (Elim)	0.05	
(Δ/L)/(Elim)	0.000790514	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(εh)/(Elim)	0.030039526	
Very Slight damage limit (Elim)	0.075	
(Δ/L)/(Elim)	0.000527009	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)	0.02002635	
Slight damage limit (Elim)	0.15	
(Δ/L)/(Elim)	0.000263505	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)	0.010013175	
Moderate damage limit (Elim)	0.3	
(Δ/L)/(Elim)	0.000131752	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)	0.005006588	

Calculated Category of Damage Negligible

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



(b) Influence of horizontal strain on ΔL / ε_{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 in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks small, blind. Reproduction probably original. 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 cracking breaking out and spalling sections of walls, especially over 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 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 will not close and require closing. Windows broken. No number of walls between. Degree of instability.	usually > 25	> 0.3

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.	23 Merton Lane Wall 3	
Closest Wall (m)	0.00	
Length (m)	17.20	
Furthest Wall (m)	17.20	
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)

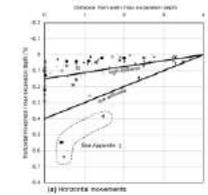
Distance to Negligible Movement (m)	
Horizontal:	6
Vertical:	5.25

Fig 2.11

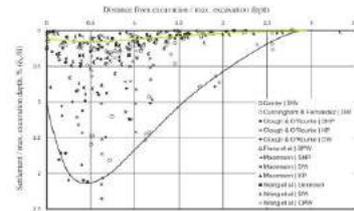
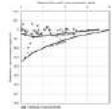
Neighbouring Property 1		No. 23 Merton Lane Wall	Interval	4.30	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth			
	A	0.00			
	B	4.30	2.87		
	D	8.60	5.73		
	E	12.90	8.60		
	F	17.20	11.47		
Horizontal Movement					
Distance (m)	%	(m)	(mm)		
0.00		0.15	0.00235	0.00 Movement at closest wall	
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	-0.00430	0.00 Movement at furthest wall	
Vertical Movement					
Distance (m)	%	(m)	(mm)		
0.00		0.04	0.00060	7.65 Movement at closest wall	
4.30		0.02	0.00027	5.36	
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)

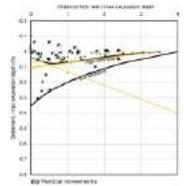
Horizontal movement calcs uses linear relationship from graph



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.

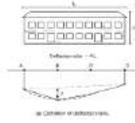
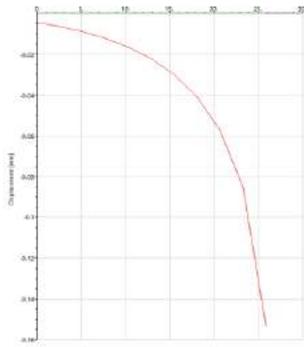


(a) Normalised settlements due to excavation in soft to firm clay



(b) Vertical movements

Potential Damage to Building



Neighbouring Property 1 No. 23 Merton Lane Wall 3

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

Vertical Deflection (Δ)	0.06 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000349 %	
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

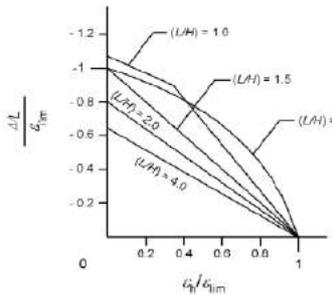
L/H	2.69
Negligible damage limit (Elim)	0.05
(Δ/L)/(Elim)	0.006976744
(εh)/(Elim)	0
Very Slight damage limit (Elim)	0.075
(Δ/L)/(Elim)	0.004651163
(εh)/(Elim)	0
Slight damage limit (Elim)	0.15
(Δ/L)/(Elim)	0.002325581
(εh)/(Elim)	0
Moderate damage limit (Elim)	0.3
(Δ/L)/(Elim)	0.001162791
(εh)/(Elim)	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)



(b) Influence of horizontal strain on ΔL / c_{crim} (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 that are visible. Repairs are usually required. Cracks are visible externally and some repairs 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. Repairs 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. Repairs are extensive. Doors and windows. Windows and frames distorted. Some repairs 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.	> 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 1 (Northern Wall)	
Closest Wall (m)	0.00	
Length (m)	12.20	
Furthest Wall (m)	12.20	
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. 25 Merton Lane Wall Interval 3.05

Contour Plot Point	Distance (m)	Distance/Max Excavation Depth		Horizontal Movement (mm)	Vertical Movement (mm)
		(m)	(mm)		
A	0.00	0.00	0.00	0.00	0.00
B	3.05	2.03	0.00	0.00	0.00
D	6.10	4.07	0.00	0.00	0.00
E	9.15	6.10	0.00	0.00	0.00
F	12.20	8.13	0.00	0.00	0.00

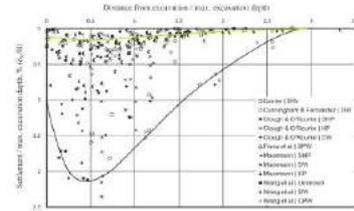
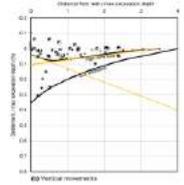
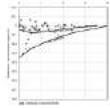
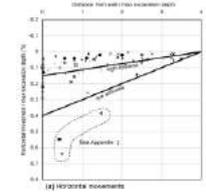
Distance (m)	%	(m)	(mm)	
0.00		0.15	0.00235	0.00 Movement at closest wall
3.05		0.07	0.00111	0.00
6.10		0.00	0.00000	0.00
9.15		-0.08	0.00000	0.00
12.20		-0.16	0.00000	0.00 Movement at furthest wall

Distance (m)	%	(m)	(mm)	
0.00		0.04	0.00060	7.65 Movement at closest wall
3.05		0.04	0.00063	5.36
6.10		-0.02	-0.00024	0.00
9.15		-0.07	-0.00112	0.00
12.20		-0.13	-0.00199	0.00000 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)

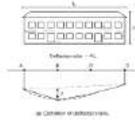
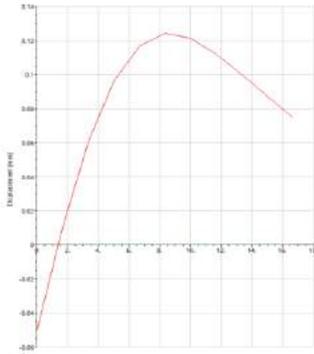
Horizontal movement calcs uses linear relationship from graph

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 1 (Northern Wall)

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

Vertical Deflection (Δ)	0.1 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000820 %	
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

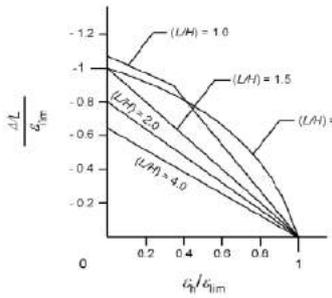
L/H	1.91
Negligible damage limit (Elim)	0.05
(Δ/L)/(Elim)	0.016393443
(Eh)/(Elim)	0
Very Slight damage limit (Elim)	0.075
(Δ/L)/(Elim)	0.010928962
(Eh)/(Elim)	0
Slight damage limit (Elim)	0.15
(Δ/L)/(Elim)	0.005464481
(Eh)/(Elim)	0
Moderate damage limit (Elim)	0.3
(Δ/L)/(Elim)	0.002732224
(Eh)/(Elim)	0

Calculated Category of Damage Negligible

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

Calculated Category of Damage Negligible

Fig 2.18 (b)



(b) Influence of horizontal strain on ΔL / εlim (after Burland, 2001)

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 fine cracked light fractures in building. Cracks in external brickwork visible on inspection.	< 1	0.05-0.075
2 Slight	Cracks that are visible and can be sealed 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 serious breaking-out and spalling of concrete. Cracks are visible internally and externally. 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 depend on number of cracks	> 0.3
5 Very severe	The structure is in a state of serious partial or complete collapse. Doors and windows may not close 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 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)

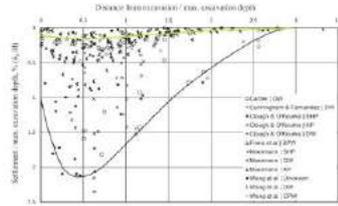
Distance to Negligible Movement (m)

Horizontal:	6
Vertical:	5.25

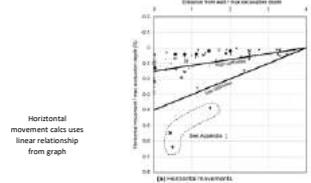
Fig 2.11

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)	%	Horizontal Movement (mm)					
	0.00	0.15	0.00	0.00	0.00	0.00	Movement at closest wall
	5.13	0.02	0.00	0.00	0.00	0.00	
	10.25	-0.11	-0.00	0.00	0.00	0.00	
	15.38	-0.23	-0.00	0.00	0.00	0.00	Movement at furthest wall
20.50	-0.36	-0.00	0.00	0.00	0.00		
Distance (m)	%	Vertical Movement (mm)					
	0.00	0.04	0.00000	7.65	0.00	0.00	Movement at closest wall
	5.13	0.00	0.00003	5.30	0.00	0.00	
	10.25	-0.10	-0.00143	2.30	0.00	0.00	
	15.38	-0.19	-0.00290	0.70	0.00	0.00	
20.50	-0.29	-0.00436	0.0045	0.00	0.00	Movement at furthest wall	

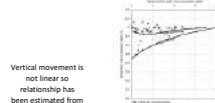
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



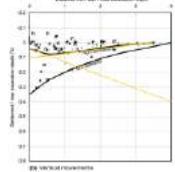
Normalised settlements due to excavation in soft to firm clay



Horizontal movement calls uses linear relationship from graph

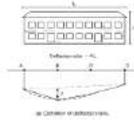
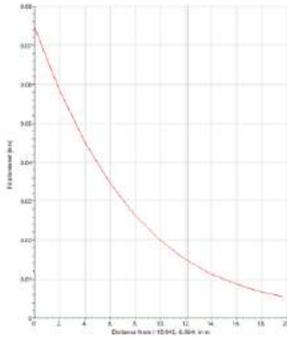


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



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)

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

Vertical Deflection (Δ) 0.02 mm from graph (max difference between blue and orange line)

Deflection Ratio (Δ/L) 0.000098 %

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

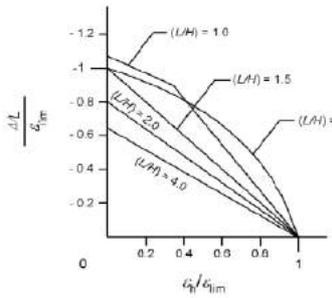
L/H	#DIV/0!	
Negligible damage limit (Elim)	0.05	
(Δ/L)/(Elim)	0.00195122	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(Eh)/(Elim)	0	
Very Slight damage limit (Elim)	0.075	
(Δ/L)/(Elim)	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
(Eh)/(Elim)	0	
Slight damage limit (Elim)	0.15	
(Δ/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
(Eh)/(Elim)	0	
Moderate damage limit (Elim)	0.3	
(Δ/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'
(Eh)/(Elim)	0	

Calculated Category of Damage Negligible

L/H	0.00	
Negligible damage limit (Elim)	0.05	
(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	
Very Slight damage limit (Elim)	0.075	
(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	
Slight damage limit (Elim)	0.15	
(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	
Moderate damage limit (Elim)	0.3	
(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 $\Delta L / c_{lim}$ (after Burland, 2001)

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	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 that are visible. Repairs are usually required. Several slight fractures around joints of building. Cracks are visible externally and some repairs 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 mason. External cracks can be sealed by suitable means. Repairs 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 serious breaking-out and spalling of concrete. Repairs are extensive. Doors and windows. Windows and frames distorted. Some repairs 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 seriously distorted and require closing. Windows broken. Some loss of weathertightness. Degree of instability.	usually > 25	> 0.5

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

Project Ref: GWP/R2950
 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)

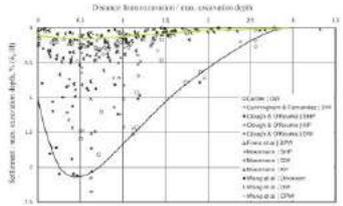
Distance to Negligible Movement (m)

Horizontal:	6
Vertical:	5.25

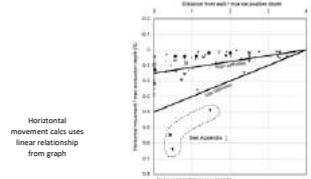
Fig 2.11

Neighbouring Property 1		No. 25 Merton Lane (W)	Interval	4.05
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth		
	A	0.00	0.00	
	B	4.05	2.70	
	D	8.10	5.40	
	E	12.15	8.10	
F	16.20	10.80		
Horizontal Movement				
Distance (m)	%	(m)	(mm)	
0.00		0.15	0.00	Movement at closest wall
4.05		0.05	0.00	
8.10		-0.05	0.00	
12.15		-0.15	0.00	
16.20		-0.26	0.00	Movement at furthest wall
Vertical Movement				
Distance (m)	%	(m)	(mm)	
0.00		0.04	0.00060	7.65 Movement at closest wall
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 Movement at furthest wall

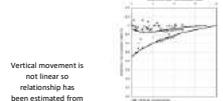
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



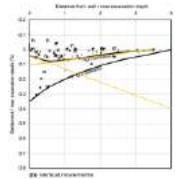
Normalised settlements due to excavation in soft to firm clay



Horizontal movement calls uses linear relationship from graph

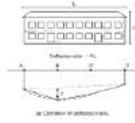
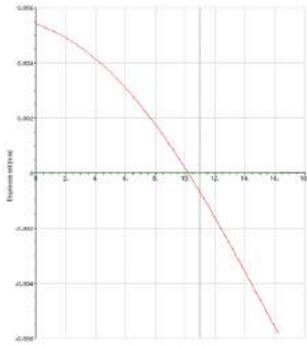


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



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)	0.002 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.00012 %	
Horizontal Movement (δh)	0.00 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ($Eh = \delta h/L$)	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

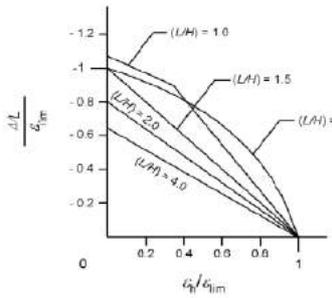
L/H	2.54
Negligible damage limit (Elim)	0.05
(Δ/L)/(Elim)	0.000246914
(Eh)/(Elim)	0
Very Slight damage limit (Elim)	0.075
(Δ/L)/(Elim)	0.000164609
(Eh)/(Elim)	0
Slight damage limit (Elim)	0.15
(Δ/L)/(Elim)	8.23045E-05
(Eh)/(Elim)	0
Moderate damage limit (Elim)	0.3
(Δ/L)/(Elim)	4.11523E-05
(Eh)/(Elim)	0

Calculated Category of Damage Negligible

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

Calculated Category of Damage Negligible

Fig 2.18 (b)



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

Table 2.5

Classification of visible damage to walls (after Burland et al, 1977; Eurocode and Corning, 1988 and Corning, 2001)

Category of damage	Description of typical damage (note 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 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 no special attention. Several slight fractures 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 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. Doors, windows, frames and panes. 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 and windows will not close 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 4)	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	15.80	Length (m)	
Furthest Wall (m)	15.80	Furthest Wall (m)	
Height	6.39	Height	

Ground Movement Due to Excavation - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

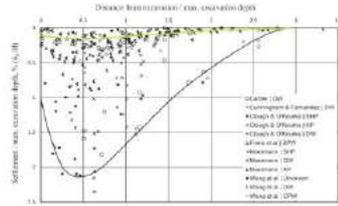
Distance to Negligible Movement (m)

Horizontal:	6
Vertical:	5.25

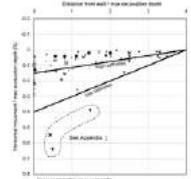
Fig 2.11

Neighbouring Property 1		No. 25 Merton Lane (W)	Interval	3.95
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth		
	A	0.00	0.00	
	B	3.95	2.63	
	D	7.90	5.27	
	E	11.85	7.90	
	F	15.80	10.53	
Horizontal Movement				
Distance (m)	%	(m)	(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
Vertical Movement				
Distance (m)	%	(m)	(mm)	
0.00		0.04	0.00060	7.65 Movement at closest wall
3.95		0.02	-0.00037	5.30
7.90		-0.05	-0.00076	2.30
11.85		-0.13	-0.00189	0.70
15.80		-0.20	-0.00302	0.0045 Movement at furthest wall

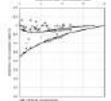
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



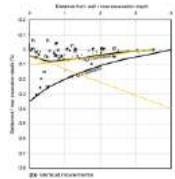
Normalised settlements due to excavation in soft to firm clay



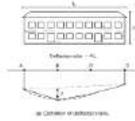
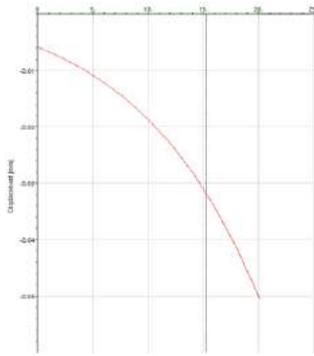
Horizontal movement calls uses linear relationship from graph



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 4)	
	m	mm
L	15.80	15800
H	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 (δ_h)	0.00 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (ϵ_h) = δ_h/L	0.00000 %	

Neighbouring Property 2 No. 0

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

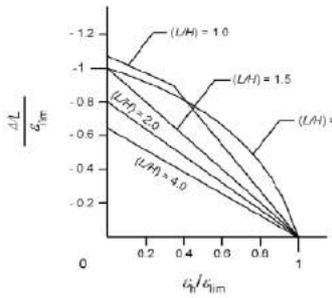
L/H	2.47
Negligible damage limit (Elim)	0.05
(Δ/L)/(Elim)	0.001265823
(ϵ_h)/(Elim)	0
Very Slight damage limit (Elim)	0.075
(Δ/L)/(Elim)	0.000843882
(ϵ_h)/(Elim)	0
Slight damage limit (Elim)	0.15
(Δ/L)/(Elim)	0.000421941
(ϵ_h)/(Elim)	0
Moderate damage limit (Elim)	0.3
(Δ/L)/(Elim)	0.00021097
(ϵ_h)/(Elim)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

Calculated Category of Damage Negligible

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

Calculated Category of Damage Negligible

Fig 2.18 (b)



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

Table 2.5

Category of damage	Description of typical damage (type 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 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. Cracks are visible externally and some repairs 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 mason. External cracks can be sealed by suitable means. Repairs 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 serious breaking-out and spalling of concrete. Repairs are extensive. Doors and windows. Windows and frames distorted. Some repairs internally. 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 are unusable. Walls lean badly and require shoring. Windows broken. No number of with-increases. 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: 7.5

Neighbouring Property 1

House No.	Western Wall 25 West Park Hill (Wall 1)
Closest Wall (m)	2.90
Length (m)	12.30
Furthest Wall (m)	15.20
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)

Distance to Negligible Movement	
Horizontal:	30
Vertical:	26.25

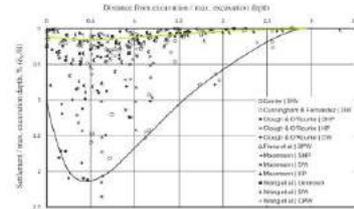
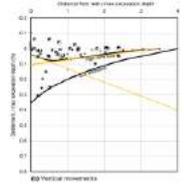
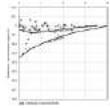
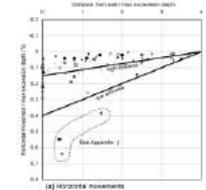
Fig 2.11

Neighbouring Property 1		No. Western Wall 25 Wt	Interval	3.08
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth		
	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)	%	Horizontal Movement		
	2.90	0.14	0.01016	10.16 Movement at closest wall
	5.98	0.12	0.00501	5.01
	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)

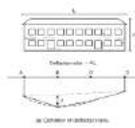
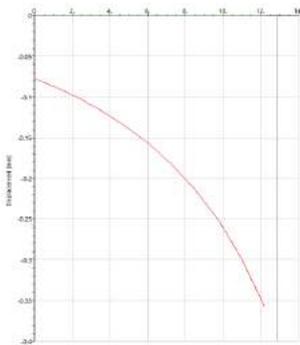
Horizontal movement calcs uses linear relationship from graph

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. 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	
Negligible damage limit (Elim)	0.05	
(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	
Very Slight damage limit (Elim)	0.075	
(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	
Slight damage limit (Elim)	0.15	
(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	
Moderate damage limit (Elim)	0.3	
(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	
Negligible damage limit (Elim)	0.05	
(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	
Very Slight damage limit (Elim)	0.075	
(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	
Slight damage limit (Elim)	0.15	
(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	
Moderate damage limit (Elim)	0.3	
(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)

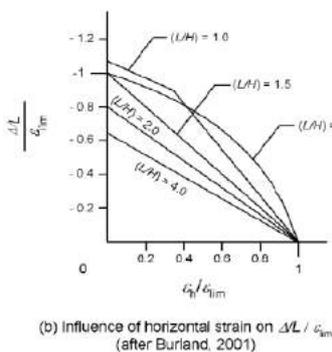


Table 2.5

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 require occasional repair. Several slight fractures 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 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 masonry. Repointing of masonry joints 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	> 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, or severely distorted. 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.	Western Wall 25 West Park Hill (Wall 1)
Closest Wall (m)	2.90
Length (m)	12.30
Furthest Wall (m)	15.20
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)

Distance to Negligible Movement	
Horizontal:	20
Vertical:	17.5

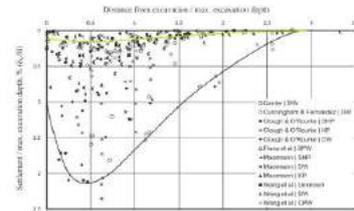
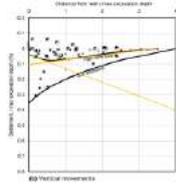
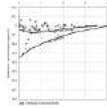
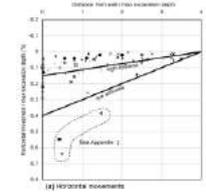
Fig 2.11

Neighbouring Property 1		No. Western Wall 25 Wt	Interval	3.08
Contour Plot Point	Distance (m)	Distance/Max		
		Excavation Depth		
A	2.90	0.58		
B	5.98	1.20		
D	9.05	1.81		
E	12.13	2.43		
F	15.20	3.04		
Distance (m)	%	Horizontal Movement		
		(m)	(mm)	
2.90	0.13	0.00641	6.41	Movement at closest wall
5.98	0.11	0.00536	5.26	
9.05	0.08	0.00411	4.11	
12.13	0.06	0.00295	2.95	
15.20	0.04	0.00180	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)

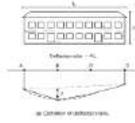
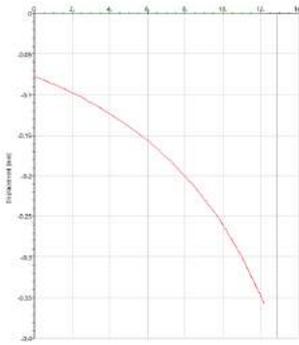
Horizontal movement calcs uses linear relationship from graph

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. 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

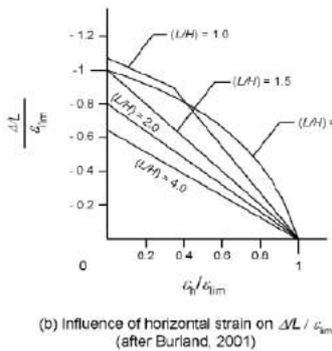
L/H	1.47	
Negligible damage limit (Elim)	0.05	
(Δ/L)/(Elim)	0.008130081	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(εh)/(Elim)	0.75	
Very Slight damage limit (Elim)	0.075	
(Δ/L)/(Elim)	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	
Slight damage limit (Elim)	0.15	
(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	
Moderate damage limit (Elim)	0.3	
(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	
Negligible damage limit (Elim)	0.05	
(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	
Very Slight damage limit (Elim)	0.075	
(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	
Slight damage limit (Elim)	0.15	
(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	
Moderate damage limit (Elim)	0.3	
(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)



(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 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, 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 weather-tightness. 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. Repainting of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Weather-tightness 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. 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 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 distorted and require closing. Windows broken. No number of walls between. 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: 7.5

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

Ground Movement Due to Excavation - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

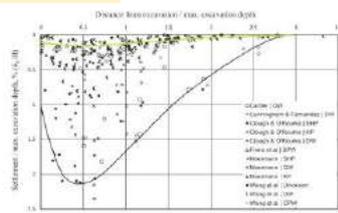
Distance to Negligible Movement

Movement (m)	(m)
Horizontal:	30
Vertical:	26.25

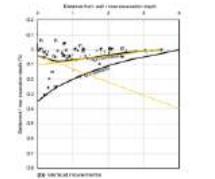
Fig 2.11

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					
Distance (m)	%	Horizontal Movement (mm)					
	0.00	0.15	7.69		Movement at closest wall		
	3.35	0.13					
	6.70	0.12					
	10.05	0.10	3.86		Movement at furthest wall		
13.40	0.08						

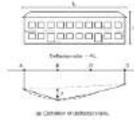
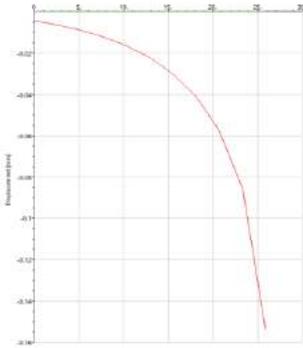
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



(c) 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)	0.05 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000373 %	
Horizontal Movement (δh)	3.83 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ($E_h = \delta h/L$)	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	
Negligible damage limit (Elim)	0.05	
(Δ/L)/(Elim)	0.007462687	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)	0.571641791	
Very Slight damage limit (Elim)	0.075	
(Δ/L)/(Elim)	0.004975124	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)	0.381094527	
Slight damage limit (Elim)	0.15	
(Δ/L)/(Elim)	0.002487562	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)	0.190547264	
Moderate damage limit (Elim)	0.3	
(Δ/L)/(Elim)	0.001243781	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)	0.095273632	

Calculated Category of Damage Negligible

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

Calculated Category of Damage Negligible

Fig 2.18 (b)

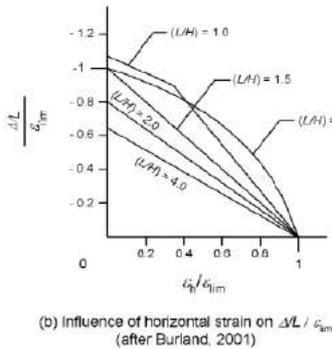


Table 2.5

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 lines indicate slight fracture in loading. Cracks are external but visible under inspection.	< 1	0.05-0.075
2 Slight	Cracks that are visible. Repairs are usually required. Cracks are visible externally and some repairs 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. Repairs of external finishes 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 opening inoperative. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes damaged.	15-25 but may exceed 30	> 0.3
5 Very severe	The structure is in danger of partial or complete collapse. Doors are inoperative, walls are badly and require closing. Windows broken. No number of walls are leaning. Degree of instability.	> 25	> 0.3

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)

Distance to Negligible Movement	
Horizontal (m)	20
Vertical (m)	17.5

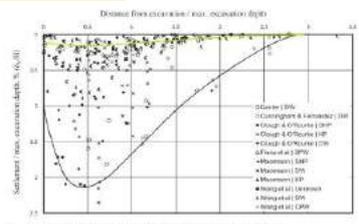
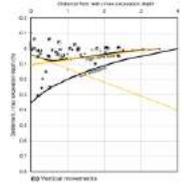
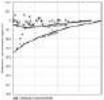
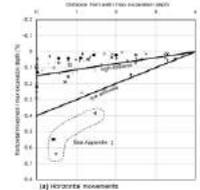
Fig 2.11

Neighbouring Property 1		No. 25 West Park Hill (A)	Interval	3.35	
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)	%	Horizontal Movement			
	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)

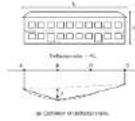
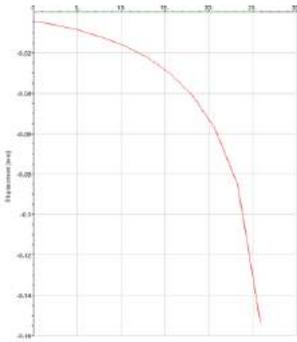
Horizontal movement calcs uses linear relationship from graph

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 West Park Hill (Wall 2)

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

Vertical Deflection (Δ)	0.05 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000373 %	
Horizontal Movement (Δh)	0.26 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (Eh) = 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	
Negligible damage limit (Elim)	0.05	
(Δ/L)/(Elim)	0.007462687	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)	0.03880597	
Very Slight damage limit (Elim)	0.075	
(Δ/L)/(Elim)	0.004975124	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)	0.025870647	
Slight damage limit (Elim)	0.15	
(Δ/L)/(Elim)	0.002487562	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)	0.012935323	
Moderate damage limit (Elim)	0.3	
(Δ/L)/(Elim)	0.001243781	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)	0.006467662	

Calculated Category of Damage Negligible

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

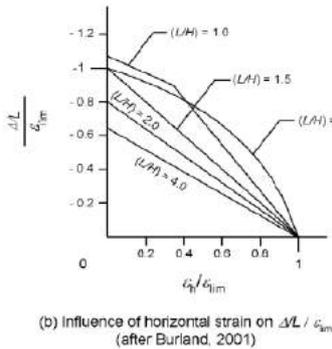


Table 2.5

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 fixtures or building. Cracks are external but visible under inspection.	< 1	0.05-0.075
2 Slight	Cracks that are visible. Repairs are usually required. Cracks are visible externally and some repairs may be required externally to ensure watertightness. 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. Repairs of external finishes and possibly a small amount of brickwork to be replaced. 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 cracking breaking out and spalling sections of walls, especially over doors and windows. 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 depend on number of cracks > 1	> 0.3
5 Very severe	The structure is in a state of serious partial or complete collapse. Doors are jammed, walls are badly and require closing. Windows broken. No number of wall sections. 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: 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)

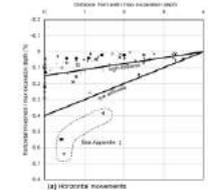
Distance to Negligible Movement	
Horizontal (m)	20
Vertical (m)	17.5

Fig 2.11

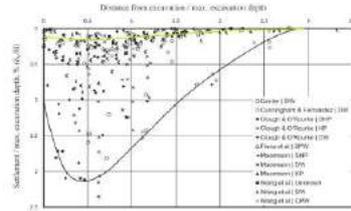
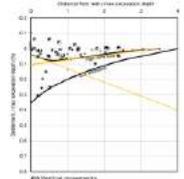
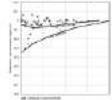
Neighbouring Property 1		No. 25 West Park Hill (A)		Interval		3.25	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth					
	A	0.00					
	B	3.25	0.65				
	D	6.50	1.30				
	E	9.75	1.95				
	F	13.00	2.60				
Distance (m)	%	Horizontal Movement (mm)					
	0.00	0.15	0.00750	1.73	Movement at closest wall		
	3.25	0.13					
	6.50	0.10					
	9.75	0.08					
	13.00	0.05	0.00263	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)

Horizontal movement calcs uses linear relationship from graph

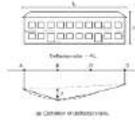
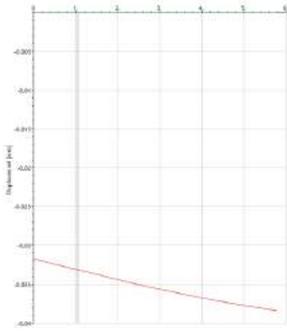


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



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

Potential Damage to Building



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

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

Vertical Deflection (Δ)	0.01 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.00077 %	
Horizontal Movement (δ_h)	1.73 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain ($\epsilon_h = \delta_h/L$)	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

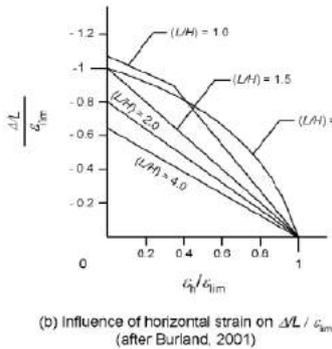
L/H	1.56	
Negligible damage limit (Elim)	0.05	
(Δ/L)/(Elim)	0.001538462	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(ϵ_h)/(Elim)	0.266153846	
Very Slight damage limit (Elim)	0.075	
(Δ/L)/(Elim)	0.001025641	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
(ϵ_h)/(Elim)	0.17435897	
Slight damage limit (Elim)	0.15	
(Δ/L)/(Elim)	0.000512821	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
(ϵ_h)/(Elim)	0.088717949	
Moderate damage limit (Elim)	0.3	
(Δ/L)/(Elim)	0.00025641	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'
(ϵ_h)/(Elim)	0.044358974	

Calculated Category of Damage Negligible

L/H	0.00	
Negligible damage limit (Elim)	0.05	
(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
(ϵ_h)/(Elim)	0	
Very Slight damage limit (Elim)	0.075	
(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
(ϵ_h)/(Elim)	0	
Slight damage limit (Elim)	0.15	
(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
(ϵ_h)/(Elim)	0	
Moderate damage limit (Elim)	0.3	
(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'
(ϵ_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 annual maintenance. The loss is not light fixtures in building. Cracks are external but visible under inspection.	< 1	0.05-0.075
2 Slight	Cracks that are visible. Repairs are usually required. Several slight fixtures are visible. Cracks are visible externally and some repairs may be required externally to ensure watertightness. 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. Repairs of external fixtures and possibly a small amount of brickwork to be replaced. Doors and windows do not close. Service pipes may fracture. Waterproofing often required.	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 opening 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	This requires a major repair involving partial or complete rebuilding. Doors are inoperative, walls are badly and require closing. Windows broken, no number of walls are leaning. Degree of instability.	greater than 25	> 0.5

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

Project Ref: GWPR2950
Site: 26 West Hill Park

Excavation Depth: 7.5

Neighbouring Property 1

House No.	25 West Park Hill (Wall 3)	
Closest Wall (m)	0.00	
Length (m)	13.00	
Furthest Wall (m)	13.00	
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

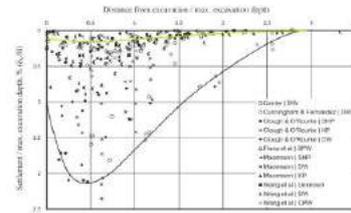
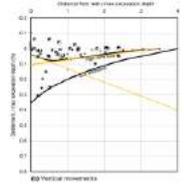
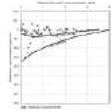
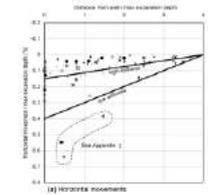
(Table 2.4 CIRIA C760)

Distance to Negligible Movement	
Horizontal:	30
Vertical:	26.25

Fig 2.11

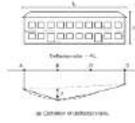
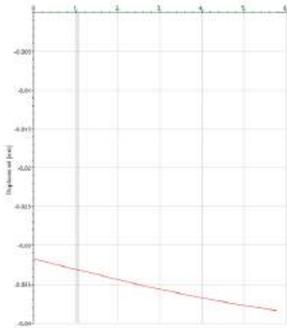
Neighbouring Property 1		No. 25 West Park Hill (A)	Interval	3.25	
Contour Plot Point	Distance (m)	Distance/Max Excavation Depth			
	A	0.00			
	B	3.25	0.43		
	D	6.50	0.87		
	E	9.75	1.30		
	F	13.00	1.73		
Distance (m)	%	Horizontal Movement			
	0.00	0.15	(mm)	3.45 Movement at closest wall	
	3.25	0.13		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



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

Potential Damage to Building



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

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

Vertical Deflection (Δ)	0.01 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.00077 %	
Horizontal Movement (δh)	1.95 mm	difference between horizontal movement at nearest and farthest walls
Horizontal Strain (Eh) = δh/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

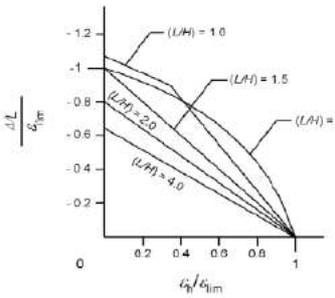
L/H	1.56
Negligible damage limit (Elim)	0.05
(Δ/L)/(Elim)	0.001538462
(Eh)/(Elim)	0.3
Very Slight damage limit (Elim)	0.075
(Δ/L)/(Elim)	0.001025641
(Eh)/(Elim)	0.2
Slight damage limit (Elim)	0.15
(Δ/L)/(Elim)	0.000512821
(Eh)/(Elim)	0.1
Moderate damage limit (Elim)	0.3
(Δ/L)/(Elim)	0.00025641
(Eh)/(Elim)	0.05

Calculated Category of Damage **Negligible**

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

Calculated Category of Damage **Negligible**

Fig 2.18 (b)



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

Table 2.5 Classification of visible damage to walls (after Burland et al, 1997; Vincennes and Gording, 1988 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 loss is not light fracture 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 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, openings, lintels and sills. 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 depend on number of cracks > 1	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Doors and windows will not close 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: GWP2950
 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)

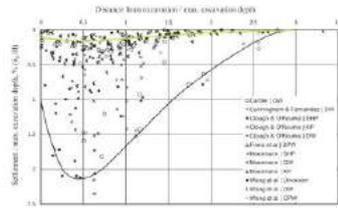
Distance to Negligible Movement (m)

Horizontal:	20
Vertical:	17.5

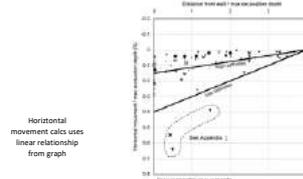
Fig 2.11

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

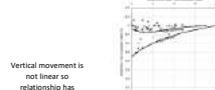
NOTE: If there are any minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



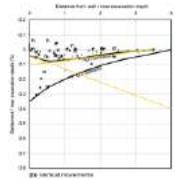
Normalised settlements due to excavation in soft to firm clay



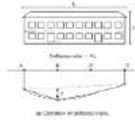
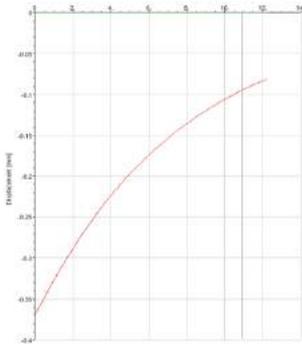
Horizontal movement calcs uses linear relationship from graph



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 (Δ)	0.05 mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000403 %	
Horizontal Movement (δ_h)	4.65 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

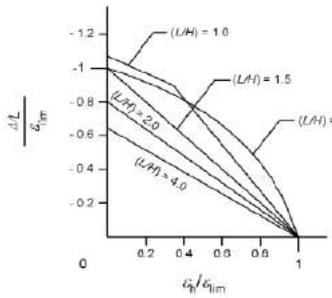
L/H	1.48
Negligible damage limit (Elim)	0.05
(Δ/L)/(Elim)	0.008064516
(ϵ_h)/(Elim)	0.75
Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below	
Very Slight damage limit (Elim)	0.075
(Δ/L)/(Elim)	0.005376344
(ϵ_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	
Slight damage limit (Elim)	0.15
(Δ/L)/(Elim)	0.002688172
(ϵ_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	
Moderate damage limit (Elim)	0.3
(Δ/L)/(Elim)	0.001344086
(ϵ_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
Negligible damage limit (Elim)	0.05
(Δ/L)/(Elim)	0
(ϵ_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	
Very Slight damage limit (Elim)	0.075
(Δ/L)/(Elim)	0
(ϵ_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	
Slight damage limit (Elim)	0.15
(Δ/L)/(Elim)	0
(ϵ_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	
Moderate damage limit (Elim)	0.3
(Δ/L)/(Elim)	0
(ϵ_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 $\Delta/L / \epsilon_{lim}$ (after Burland, 2001)

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 inspection. 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 and can be repaired during annual inspection. 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 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 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 masonry. Repointing of masonry joints 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 25	> 0.3
5 Very severe	The masonry is in a state of serious partial or complete disintegration. Doors are inoperative, walls are badly and require closing. Windows broken. Walls leaning. Degree of instability.	> 25	> 0.5