Appendix F
Ground Movement Assessment Calculations (Stage 4)

Ground Movement Analysis - CIRIA C760 Embedded Retaning 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 Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

Neighbouring Property 1 No. 23 Merton Lane Wa Interval 3.53

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

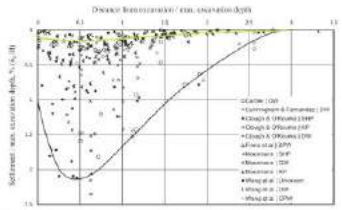
Horizontal Movement

Distance (m)	%	(m)	(mm)		
0.00		0.15	0.00225	**0.38**	Movement at closest wall
3.53		0.06	0.00093	0.00	
7.05		-0.03	-0.00039	0.00	
10.58		-0.11	-0.00172	0.00	
14.10		-0.20	-0.00304	**0.00**	Movement at furthest wall

Vertical Movement

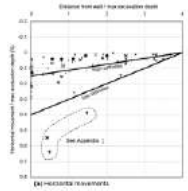
Distance (m)	%	(m)	(mm)		
0.00		0.04	0.00060	**7.65**	Movement at closest wall
3.53		0.03	0.00049	**5.30**	
7.05		-0.03	-0.00052	**2.30**	
10.58		-0.10	-0.00152	**0.70**	
14.10		-0.17	-0.00253	**0.0045**	Movement at furthest wall

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

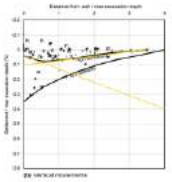


a Normalised settlements due to excavation in soft to firm clay

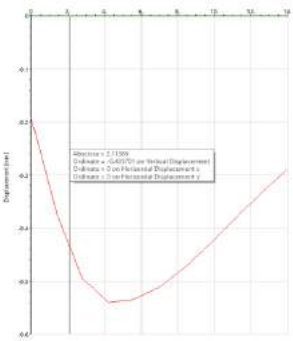
Horizontal movement calcs uses linear relationship from graph

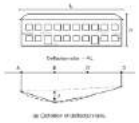


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





Neighbouring Property 1 No. 23 Merton Lane Wall 1

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

Vertical Deflection (Δ)	0.29	mm	from graph (max difference between blue and orange line)
Defelction Ratio (Δ/L)	0.002057	%	
Horizontal Movement (δh)	0.38	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.00270	%	

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

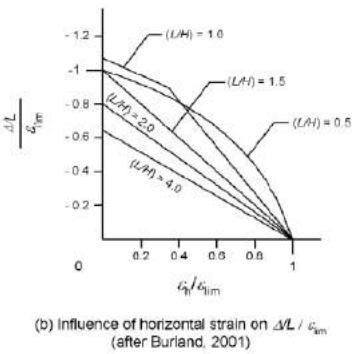
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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)	0.041134752	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(Eh)/(Elim)	0.053900709	
Very Slight damage limit (Elim)	**0.075**	
(Δ/L)/(Elim)	0.027423168	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(Eh)/(Elim)	0.035933806	
Slight damage limit (Elim)	**0.15**	
(Δ/L)/(Elim)	0.013711584	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(Eh)/(Elim)	0.017966903	
Moderate damage limit (Elim)	**0.3**	
(Δ/L)/(Elim)	0.006855792	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(Eh)/(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
(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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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

Ground Movement Analysis - CIRIA C760 Embedded Retaning 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 2	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	25.30	Length (m)	
Furthest Wall (m)	25.30	Furthest Wall (m)	
Height	6.39	Height	

Ground Movement Due to Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

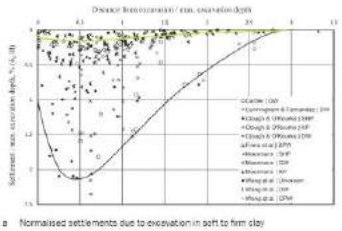
Neighbouring Property 1 No. 23 Merton Lane Wa Interval 6.33

Contour Plot Point	Distance (m)	Distance/Max Excavtion Depth	
A	0.00	0.00	
B	6.33	4.22	
D	12.65	8.43	
E	18.98	12.65	
F	25.30	16.87	

Horizontal Movement

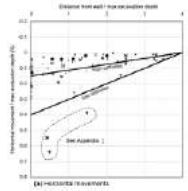
Distance (m)	%	(m)	(mm)	
0.00		0.15	**0.38**	Movement at closest wall
6.33		-0.01	0.00	
12.65		-0.17	0.00	
18.98		-0.32	0.00	
25.30		-0.48	**0.00**	Movement at furthest wall

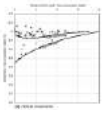
NOTE: If there are any are minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



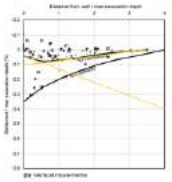
a Normalised settlements due to excavation in soft to firm clay

Horizontal movement calcs uses linear relationship from graph

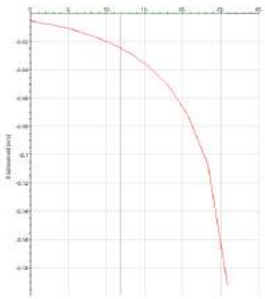


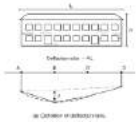


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





Neighbouring Property 1 No. 23 Merton Lane Wall 2

	m	mm	
L	25.30	25300	
H	6.39	6390	
L/H	3.96		
Vertical Deflection (Δ)	0.08	mm	from graph (max difference between blue and orange line)
Defelction Ratio (Δ/L)	0.000316	%	
Horizontal Movement (δh)	0.38	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.00150	%	

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

Method 1 - Prefferred method
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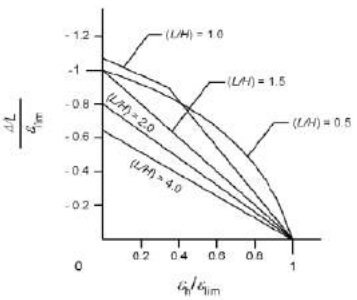
L/H	3.96	
Negligible damage limit (Elim)	**0.05**	
(Δ/L)/(Elim)	0.006324111	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(Eh)/(Elim)	0.030039526	
Very Slight damage limit (Elim)	**0.075**	
(Δ/L)/(Elim)	0.004216074	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)	0.02002635	
Slight damage limit (Elim)	**0.15**	
(Δ/L)/(Elim)	0.002108037	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)	0.010013175	
Moderate damage limit (Elim)	**0.3**	
(Δ/L)/(Elim)	0.001054018	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)	0.005006588	
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
(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 Δ/L / ε_{lim} (after Burland, 2001)

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

Ground Movement Analysis - CIRIA C760 Embedded Retaning 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 3	House No.	
Closest Wall (m)	0.00	Closest Wall (m)	
Length (m)	17.20	Length (m)	
Furthest Wall (m)	17.20	Furthest Wall (m)	
Height	6.39	Height	

Ground Movement Due to Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

Neighbouring Property 1 No. 23 Merton Lane Wa Interval 4.30

Contour Plot Point	Distance (m)	Distance/Max Excavtion Depth
A	0.00	0.00
B	4.30	2.87
D	8.60	5.73
E	12.90	8.60
F	17.20	11.47

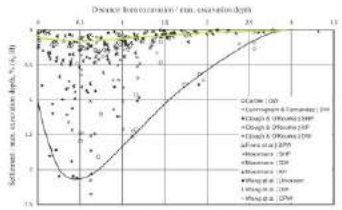
Horizontal Movement

Distance (m)	%	(m)	(mm)		
0.00	0.15	0.00225	**0.00**	Movement at closest wall
4.30	0.04	0.00064	0.00	
8.60	-0.07	-0.00098	0.00	
12.90	-0.17	-0.00259	0.00	
17.20	-0.28	-0.00420	**0.00**	Movement at furthest wall

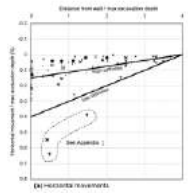
Vertical Movement

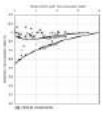
Distance (m)	%	(m)	(mm)		
0.00	0.04	0.00060	**7.65**	Movement at closest wall
4.30	0.02	0.00027	**5.30**	
8.60	-0.06	-0.00096	**2.30**	
12.90	-0.15	-0.00219	**0.70**	
17.20	-0.23	-0.00342	**0.0045**	Movement at furthest wall

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

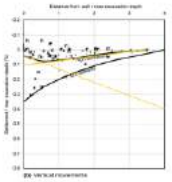


a Normalised settlements due to excavation in soft to firm clay

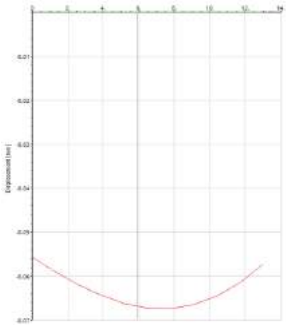


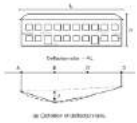


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





Neighbouring Property 1 No. 23 Merton Lane Wall 3

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

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

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

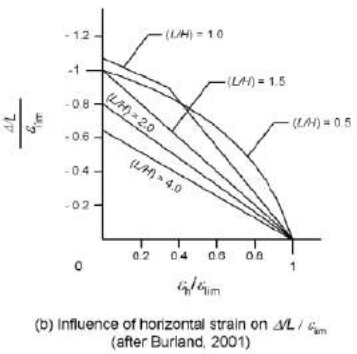
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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)	0.013953488	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)	0.009302326	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)	0.004651163	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)	0.002325581	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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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

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

Project Ref: GWPR2950
Site: 26 West Hill Park

Excavation Depth: 1.5

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

Ground Movement Due to Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

Neighbouring Property 1 No. 25 Merton Lane Wa Interval 3.05

Contour Plot Point	Distance (m)	Distance/Max Excavtion Depth
A	0.00	0.00
B	3.05	2.03
D	6.10	4.07
E	9.15	6.10
F	12.20	8.13

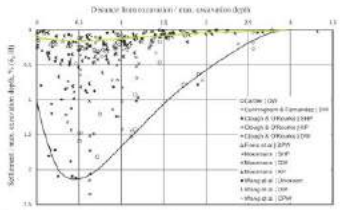
Horizontal Movement

Distance (m)	%	(m)	(mm)	
0.00	0.15	0.00225	**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

Vertical Movement

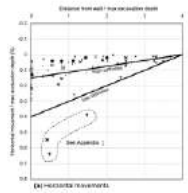
Distance (m)	%	(m)	(mm)	
0.00	0.04	0.00060	**7.65**	Movement at closest wall
3.05	0.04	0.00063	**5.30**	
6.10	-0.02	-0.00024	**0.00**	
9.15	-0.07	-0.00112	**0.00**	
12.20	-0.13	-0.00199	**0.0000**	Movement at furthest wall

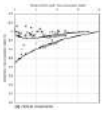
NOTE: If there are any are minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



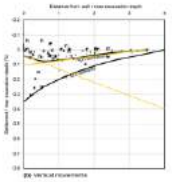
a Normalised settlements due to excavation in soft to firm clay

Horizontal movement calcs uses linear relationship from graph

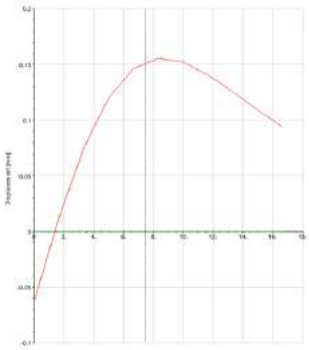


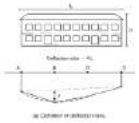


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





Neighbouring Property 1 No. 25 Merton Lane Wall 1

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

Vertical Deflection (Δ)	0.131	mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.001074	%	
Horizontal Movement (δh)	0.00	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.00000	%	

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

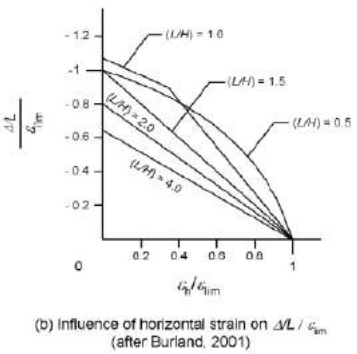
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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)	0.02147541	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)	0.01431694	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)	0.00715847	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)	0.003579235	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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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

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

Project Ref: GWPR2950
Site: 26 West Hill Park

Excavation Depth: 1.5

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

Ground Movement Due to Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

Neighbouring Property 1 No. 25 Merton Lane (Wa Interval 5.13

Contour Plot Point	Distance (m)	Distance/Max Excavtion 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

Horizontal Movement

Distance (m)	%	(m)	(mm)		
0.00	0.15	0.00225	**0.00**	Movement at closest wall
5.13	0.02	0.00033	0.00	
10.25	-0.11	-0.00159	0.00	
15.38	-0.23	0.00000	0.00	
20.50	-0.36	0.00000	**0.00**	Movement at furthest wall

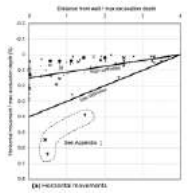
Vertical Movement

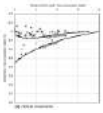
Distance (m)	%	(m)	(mm)		
0.00	0.04	0.00060	**7.65**	Movement at closest wall
5.13	0.00	0.00003	**5.30**	
10.25	-0.10	-0.00143	**2.30**	
15.38	-0.19	-0.00290	**0.70**	
20.50	-0.29	-0.00436	**0.0045**	Movement at furthest wall

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

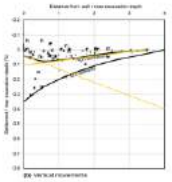
Vertical Movement

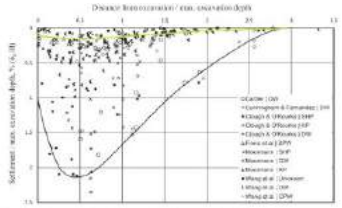
Distance (m)	%	(m)	(mm)		
0.00	0.04	0.00060	**0.60**	Movement at closest wall
0.00	0.04	0.00060	0.60	
0.00	0.04	0.00060	0.60	
0.00	0.04	0.00060	0.60	
0.00	0.04	0.00060	**0.60**	Movement at furthest wall





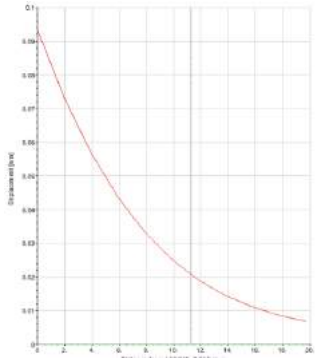
Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.

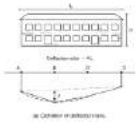




a Normalised settlements due to excavation in soft to firm clay

Potential Damage to Building





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

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

Vertical Deflection (Δ)	0.02	mm	from graph (max difference between blue and orange line)
Defelction Ratio (Δ/L)	0.000098	%	
Horizontal Movement (δh)	0.00	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.00000	%	

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

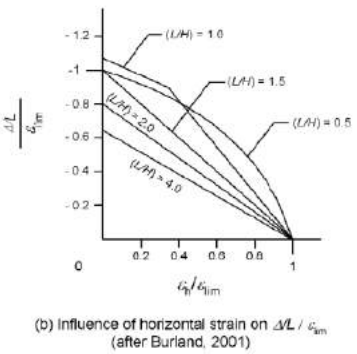
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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
(Eh)/(Elim)	0	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)	0.001300813	Plot this point on fig2.18 (b) if the plotted point is below
(Eh)/(Elim)	0	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)	0.000650407	Plot this point on fig2.18 (b) if the plotted point is below
(Eh)/(Elim)	0	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)	0.000325203	Plot this point on fig2.18 (b) if the plotted point is below
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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

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

Project Ref: GWPR2950
Site: 26 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 Excavtion - 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 (We Interval 4.05

Contour Plot Point	Distance (m)	Distance/Max Excavtion 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

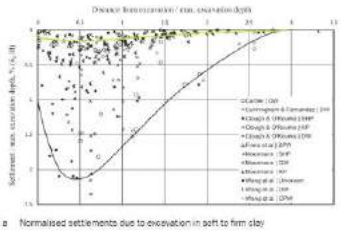
Horizontal Movement

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

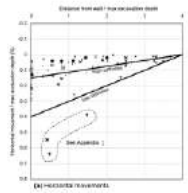
Distance (m)	%	(m)	(mm)	
0.00		0.04	0.00060	**7.65** Movement at closest wall
4.05		0.02	0.00034	**5.30**
8.10		-0.05	-0.00082	**2.30**
12.15		-0.13	-0.00197	**0.70**
16.20		-0.21	-0.00313	**0.0045** Movement at furthest wall

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

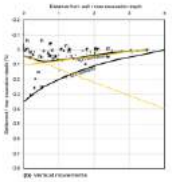


a Normalised settlements due to excavation in soft to firm clay

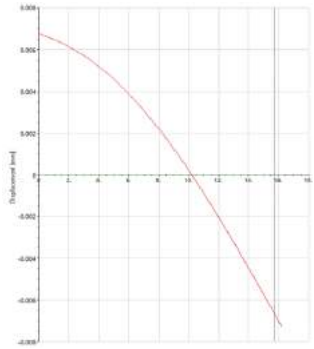
Horizontal movement calcs uses linear relationship from graph

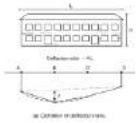


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





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

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

Vertical Deflection (Δ)	0.0022	mm	from graph (max difference between blue and orange line)
Defelction Ratio (Δ/L)	0.000014	%	
Horizontal Movement (δh)	0.00	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.00000	%	

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

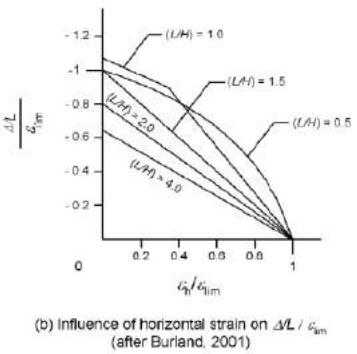
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs
- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

L/H	2.54	
Negligible damage limit (Elim)	**0.05**	
(Δ/L)/(Elim)	0.000271605	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)	0.00018107	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)	9.0535E-05	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)	4.5267SE-05	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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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

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.	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 Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

Neighbouring Property 1 No. 25 Merton Lane (Wa Interval 3.95

Contour Plot Point	Distance (m)	Distance/Max Excavtion 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

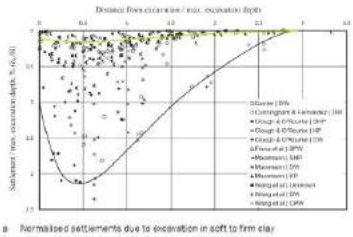
Horizontal Movement

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

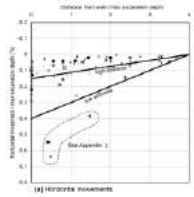
Distance (m)	%	(m)	(mm)	
0.00		0.04	0.00060	**7.65** Movement at closest wall
3.95		0.02	0.00037	**5.30**
7.90		-0.05	-0.00076	**2.30**
11.85		-0.13	-0.00189	**0.70**
15.80		-0.20	-0.00302	**0.0045** Movement at furthest wall

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

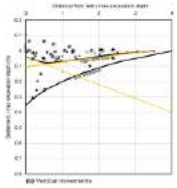


a Normalised settlements due to excavation in soft to firm clay

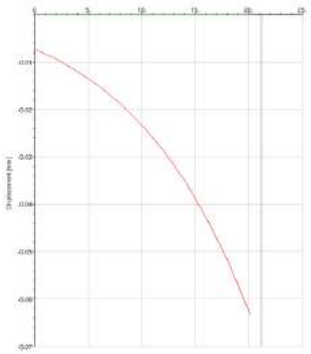
Horizontal movement calcs uses linear relationship from graph

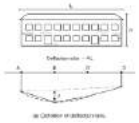


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





Neighbouring Property 1 No. 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)
Defelction Ratio (Δ/L)	0.000063	%	
Horizontal Movement (δh)	0.00	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.00000	%	

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

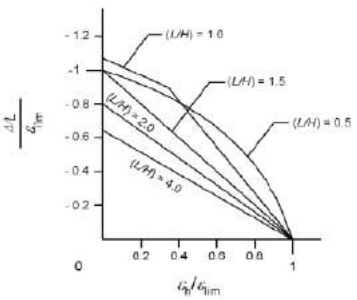
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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	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)	0.000843882	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)	0.000421941	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)	0.00021097	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 $\Delta L / \varepsilon_{lim}$ (after Burland, 2001)

Table 2.5

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

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

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

Project Ref: GWPR2950
Site: 26 West Hill Park

Excavation Depth: 7.5

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

Ground Movement Due to Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

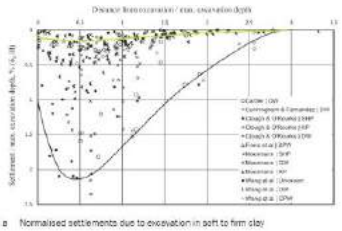
Neighbouring Property 1 No. Western Wall 25 We Interval 3.08

Contour Plot Point	Distance (m)	Distance/Max Excavtion 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

Horizontal Movement

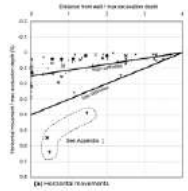
Distance (m)	%	(m)	(mm)		
2.90		0.14	0.01016	**10.16**	Movement at closest wall
5.98		0.12	0.00901	9.01	
9.05		0.10	0.00786	7.86	
12.13		0.09	0.00670	6.70	
15.20		0.07	0.00555	**5.55**	Movement at furthest wall

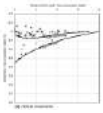
NOTE: If there are any are minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



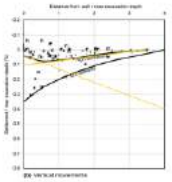
a Normalised settlements due to excavation in soft to firm clay

Horizontal movement calcs uses linear relationship from graph

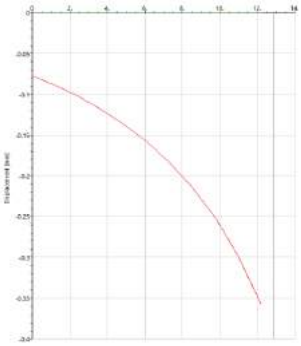


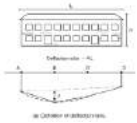


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





Neighbouring Property 1 No. Western Wall 25 West Park Hill (Wall 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
Horzontal Strain (Eh) = δh/L	0.03750	%	

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

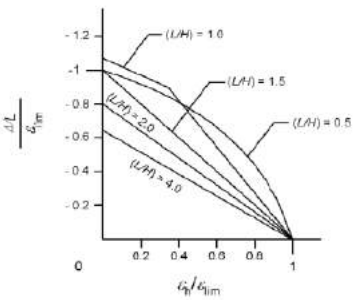
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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
(Eh)/(Elim)	0.75	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)	0.005420054	Plot this point on fig2.18 (b) if the plotted point is below
(Eh)/(Elim)	0.5	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)	0.002710027	Plot this point on fig2.18 (b) if the plotted point is below
(Eh)/(Elim)	0.25	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)	0.001355014	Plot this point on fig2.18 (b) if the plotted point is below
(Eh)/(Elim)	0.125	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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

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

Project Ref: GWPR2950
Site: 26 West Hill Park

Excavation Depth: 5

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

Ground Movement Due to Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

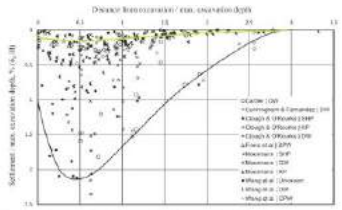
Fig 2.11

Neighbouring Property 1 No. Western Wall 25 We Interval 3.08

Contour Plot Point	Distance (m)	Distance/Max Excavtion 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

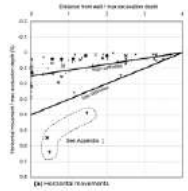
Distance (m)	%	**Horizontal Movement** (m)	(mm)	
2.90	0.13	0.00641	**6.41**	Movement at closest wall
5.98	0.11	0.00526	5.26	
9.05	0.08	0.00411	4.11	
12.13	0.06	0.00295	2.95	
15.20	0.04	0.00180	**1.80**	Movement at furthest wall

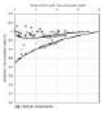
NOTE: If there are any are minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



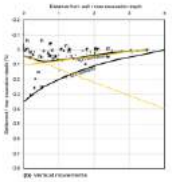
a Normalised settlements due to excavation in soft to firm clay

Horizontal movement calcs uses linear relationship from graph

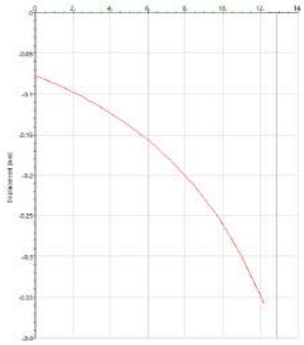


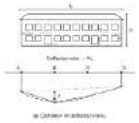


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





Neighbouring Property 1 No. Western Wall 25 West Park Hill (Wall 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
Horzontal Strain (Eh) = δh/L	0.03750	%	

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

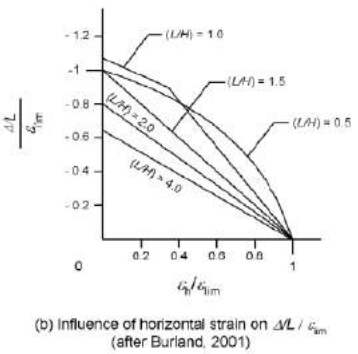
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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
(Eh)/(Elim)	0.75	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)	0.005420054	Plot this point on fig2.18 (b) if the plotted point is below
(Eh)/(Elim)	0.5	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)	0.002710027	Plot this point on fig2.18 (b) if the plotted point is below
(Eh)/(Elim)	0.25	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)	0.001355014	Plot this point on fig2.18 (b) if the plotted point is below
(Eh)/(Elim)	0.125	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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	Plot this point on fig2.18 (b) if the plotted point is below the
(Eh)/(Elim)	0	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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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

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

Project Ref: GWPR2950
Site: 26 West Hill Park

Excavation Depth: 7.5

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

Ground Movement Due to Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

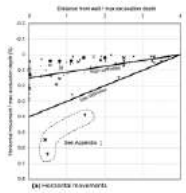
Neighbouring Property 1 No. 25 West Park Hill (W Interval 3.35

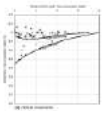
Contour Plot Point	Distance (m)	Distance/Max Excavtion Depth
A	0.00	0.00
B	3.35	0.45
D	6.70	0.89
E	10.05	1.34
F	13.40	1.79

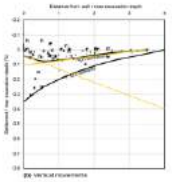
Horizontal Movement

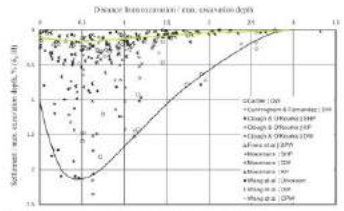
Distance (m)	%	(m)	(mm)	
0.00		0.15	**7.69**	Movement at closest wall
3.35		0.13		
6.70		0.12		
10.05		0.10		
13.40		0.08	**3.86**	Movement at furthest wall

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



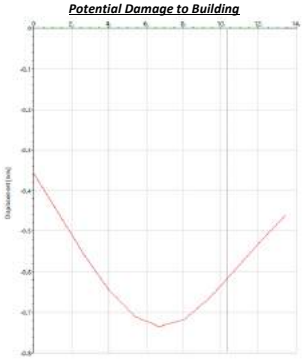


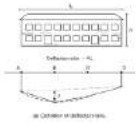




a Normalised settlements due to excavation in soft to firm clay

Potential Damage to Building





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

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

Vertical Deflection (Δ)	0.39	mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.002910	%	
Horizontal Movement (δh)	3.83	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.02858	%	

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

Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
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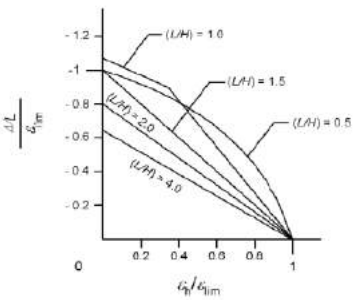
Method 2 - can be used to confirm category or is useful if L/H for property is between the given L/H graphs
- Plot points calculated below on figure 2.18 for each damage category
- Appropriate damage category will plot below L/H for property

L/H	1.60	
Negligible damage limit (Elim)	**0.05**	
(Δ/L)/(Elim)	0.058208955	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(Eh)/(Elim)	0.571641791	
Very Slight damage limit (Elim)	**0.075**	
(Δ/L)/(Elim)	0.03880597	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(Eh)/(Elim)	0.381094527	
Slight damage limit (Elim)	**0.15**	
(Δ/L)/(Elim)	0.019402985	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(Eh)/(Elim)	0.190547264	
Moderate damage limit (Elim)	**0.3**	
(Δ/L)/(Elim)	0.009701493	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(Eh)/(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
(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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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

Ground Movement Analysis - CIRIA C760 Embedded Retaning 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 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 Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

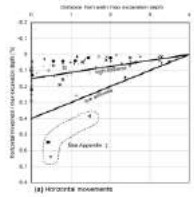
Neighbouring Property 1 No. 25 West Park Hill W. Interval 3.35

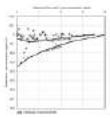
Contour Plot Point	Distance (m)	Distance/Max Excavtion Depth
A	0.00	0.00
B	3.35	0.67
D	6.70	1.34
E	10.05	2.01
F	13.40	2.68

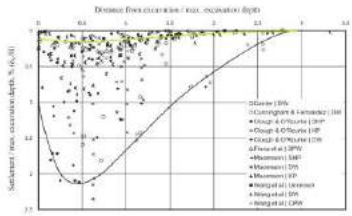
Horizontal Movement

Distance (m)	%	(m)	(mm)	
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

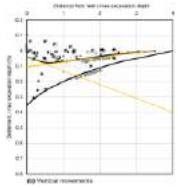
NOTE: If there are any are minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



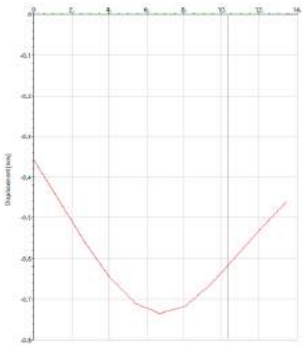


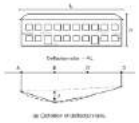


a Normalised settlements due to excavation in soft to firm clay



Potential Damage to Building





Neighbouring Property 1 No. 25 West Park Hill Wall 2

	m	mm	
L	13.40	13400	
H	8.36	8360	
L/H	1.60		
Vertical Deflection (Δ)	0.39	mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.002910	%	
Horizontal Movement (δh)	0.26	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.00194	%	

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

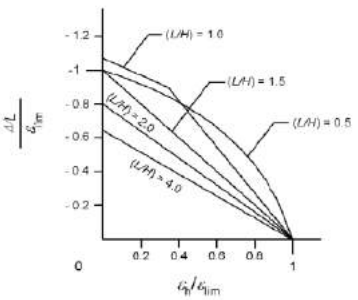
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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



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

Table 2.5

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

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

Ground Movement Analysis - CIRIA C760 Embedded Retaning 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 Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

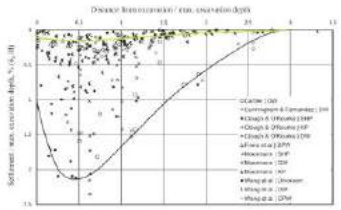
Neighbouring Property 1 No. 25 West Park Hill (W Interval 3.25

Contour Plot Point	Distance (m)	Distance/Max Excavtion Depth
A	0.00	0.00
B	3.25	0.65
D	6.50	1.30
E	9.75	1.95
F	13.00	2.60

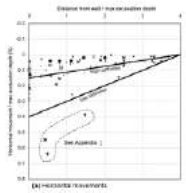
Horizontal Movement

Distance (m)	%	(m)	(mm)	
0.00		0.15	**1.73**	Movement at closest wall
3.25		0.13		
6.50		0.10		
9.75		0.08		
13.00		0.05	**0.00**	Movement at furthest wall

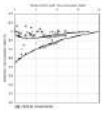
NOTE: If there are any are minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



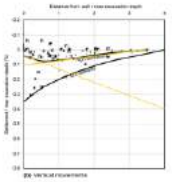
a Normalised settlements due to excavation in soft to firm clay



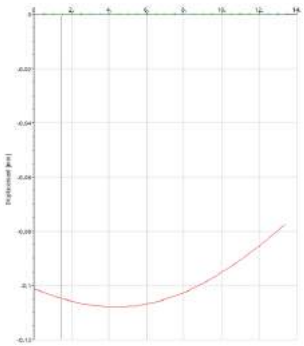
Horizontal movement calcs uses linear relationship from graph

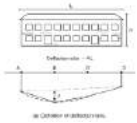


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





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

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

Vertical Deflection (Δ)	0.012	mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000092	%	
Horizontal Movement (δh)	1.73	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.01331	%	

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

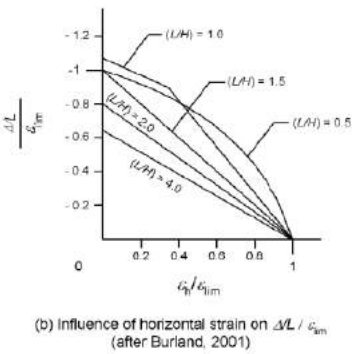
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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)	0.001846154	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(Eh)/(Elim)	0.266153846	
Very Slight damage limit (Elim)	**0.075**	
(Δ/L)/(Elim)	0.001230769	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(Eh)/(Elim)	0.177435897	
Slight damage limit (Elim)	**0.15**	
(Δ/L)/(Elim)	0.000615385	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(Eh)/(Elim)	0.088717949	
Moderate damage limit (Elim)	**0.3**	
(Δ/L)/(Elim)	0.000307692	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(Eh)/(Elim)	0.044358974	
Calculated Category of Damage	Negligible	

L/H	0.00	
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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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

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

Project Ref: GWPR2950
Site: 26 West Hill Park

Excavation Depth: 7.5

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

Ground Movement Due to Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

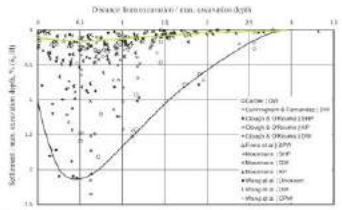
Neighbouring Property 1 No. 25 West Park Hill (W Interval 3.25

Contour Plot Point	Distance (m)	Distance/Max Excavtion Depth
A	0.00	0.00
B	3.25	0.43
D	6.50	0.87
E	9.75	1.30
F	13.00	1.73

Horizontal Movement

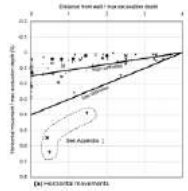
Distance (m)	%	(m)	(mm)	
0.00		0.15	**3.45**	Movement at closest wall
3.25		0.13		
6.50		0.12		
9.75		0.10		
13.00		0.09	**1.50**	Movement at furthest wall

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

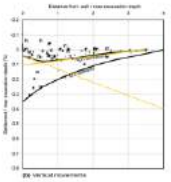


a Normalised settlements due to excavation in soft to firm clay

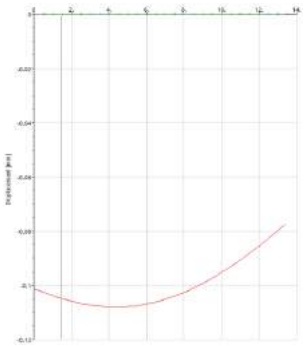
Horizontal movement calcs uses linear relationship from graph

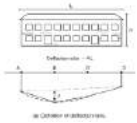


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



Potential Damage to Building





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

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

Vertical Deflection (Δ)	0.012	mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000092	%	
Horizontal Movement (δh)	1.95	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.01500	%	

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

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- Open up 'Damage Category Relationship Plots GMA' spreadsheet
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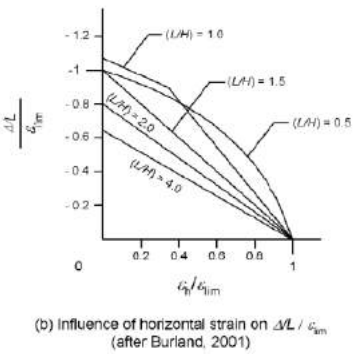
L/H	1.56	
Negligible damage limit (Elim)	**0.05**	
(Δ/L)/(Elim)	0.001846154	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'negligible' category - no need to plot points below
(Eh)/(Elim)	0.3	
Very Slight damage limit (Elim)	**0.075**	
(Δ/L)/(Elim)	0.001230769	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'very slight' category - no need to plot points below
(Eh)/(Elim)	0.2	
Slight damage limit (Elim)	**0.15**	
(Δ/L)/(Elim)	0.000615385	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'slight' category - no need to plot points below
(Eh)/(Elim)	0.1	
Moderate damage limit (Elim)	**0.3**	
(Δ/L)/(Elim)	0.000307692	Plot this point on fig2.18 (b) if the plotted point is below the appropriate L/H line then damage falls into 'moderate' category - if the point is not below, damage is 'severe'
(Eh)/(Elim)	0.05	
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 Δ/L / ε_{lim} (after Burland, 2001)

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0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible	< 0.1	0.0–0.05
1 Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection.	< 1	0.05–0.075
2 Slight	Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly.	< 5	0.075–0.15
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4 Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 but may depend on number of cracks	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	usually > 25 but depends on number of cracks.	

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

Project Ref: GWPR2950
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)	
Furthest Wall (m)	15.50	Furthest Wall (m)	
Height	8.36	Height	

Ground Movement Due to Excavtion - Assuming Soft to Firm Clay

(Table 2.4 CIRIA C760)

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

Fig 2.11

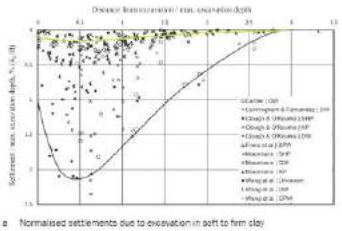
Neighbouring Property 1 No. Western Wall 25 We Interval 3.10

Contour Plot Point	Distance (m)	Distance/Max Excavtion 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	

Horizontal Movement

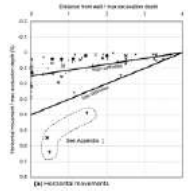
Distance (m)	%	(m)	(mm)	
3.10	0.13	0.00634	**6.34**	Movement at closest wall
6.20	0.10	0.00518	5.18	
9.30	0.08	0.00401	4.01	
12.40	0.06	0.00285	2.85	
15.50	0.03	0.00169	**1.69**	Movement at furthest wall

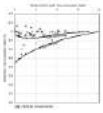
NOTE: If there are any are minus numbers change to 0 (Distance is more than distance to negligible movement from Table 2.4)



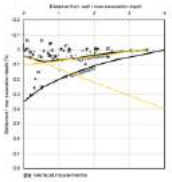
a Normalised settlements due to excavation in soft to firm clay

Horizontal movement calcs uses linear relationship from graph

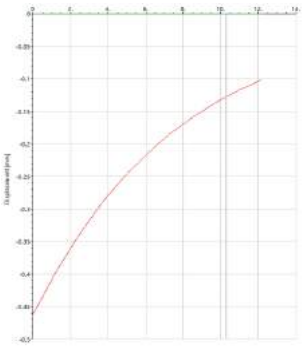


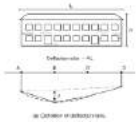


Vertical movement is not linear so relationship has been estimated from graph. The estimated relationship used in spreadsheet is shown in orange in graph below.



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)	0.08	mm	from graph (max difference between blue and orange line)
Deflection Ratio (Δ/L)	0.000645	%	
Horizontal Movement (δh)	4.65	mm	difference between horizontal movement at nearest and farthest walls
Horzontal Strain (Eh) = δh/L	0.03750	%	

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

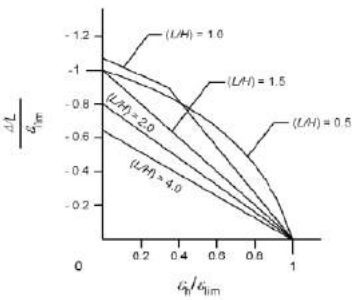
Method 1 - Prefferred method
- Open up 'Damage Category Relationship Plots GMA' spreadsheet
- Find relevant L/H graph (different graph on each each tab along the bottom of the spreadsheet)
- Input calculated values for deflection ratio and horizontal strain
- Point will plot on graph and show category of dameg

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)	0.012903226	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)	0.75	
Very Slight damage limit (Elim)	**0.075**	
(Δ/L)/(Elim)	0.008602151	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)	0.5	
Slight damage limit (Elim)	**0.15**	
(Δ/L)/(Elim)	0.004301075	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)	0.25	
Moderate damage limit (Elim)	**0.3**	
(Δ/L)/(Elim)	0.002150538	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)	0.125	
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
(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 Δ/L / ε_{lim} (after Burland, 2001)

Table 2.5

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

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