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Consulting Engineers

Job No 24077 Page 0-1 Ver
Date 8/2/16 Eng K Chd
Job 3 ALDRED ROAD.

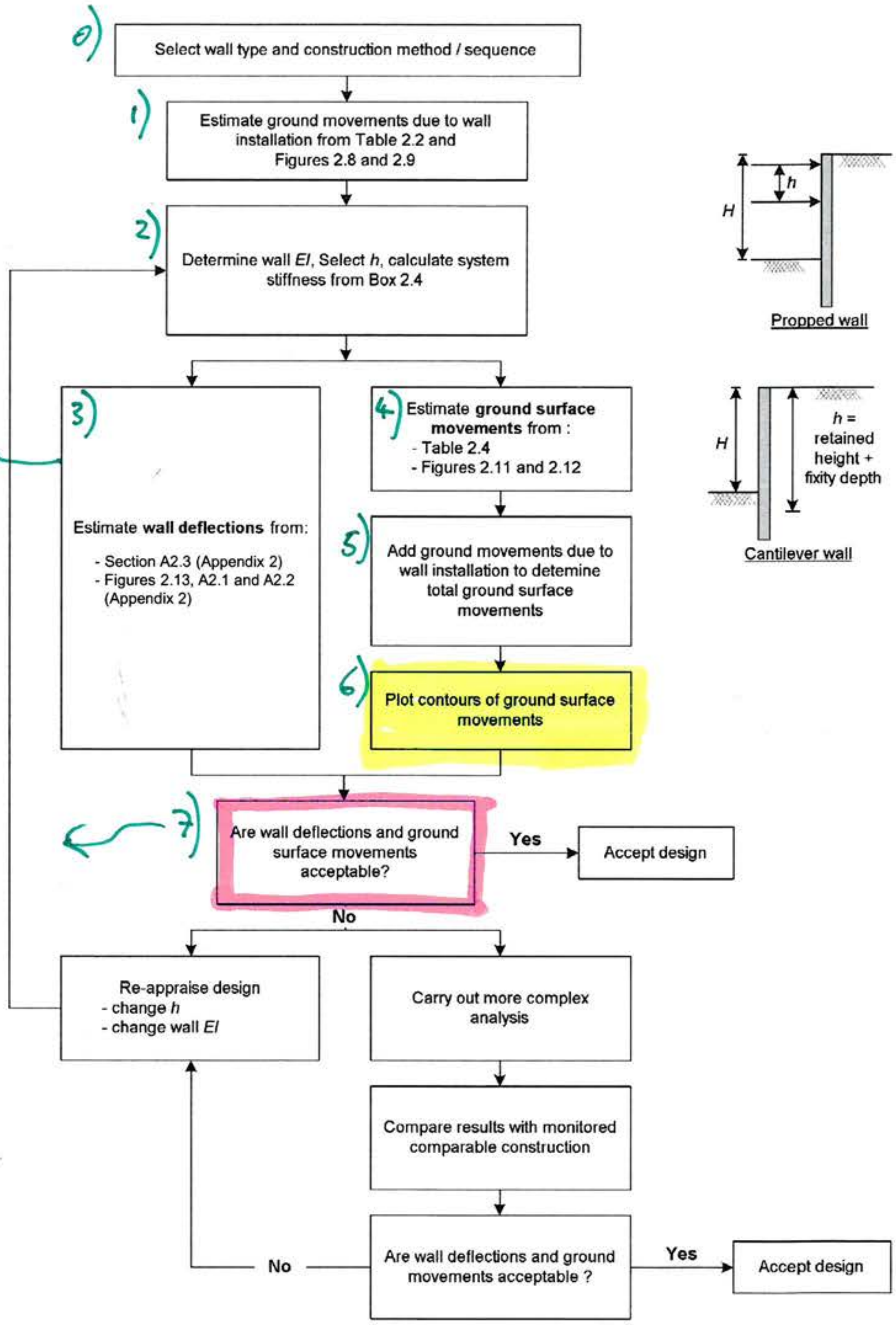
SUPPLEMENTARY CALCULATIONS TO ASSESS GROUND MOVEMENTS & BUILDING DAMAGE TO BURLAND / CIRIA C580.

- FOLLOWING THE PROCESS Fig 2.14 of CIRIA C580 (2003) (COPY ATTACHED OVER-LEAF).

- CHECKS FOR WORST CASE - MAIN EXCAVATION TO FRONT TO FORMATION LEVEL (3+m). NEGLECT EXISTING FOUNDATION DEPTH BELOW HOUSE + ASSESS MOVEMENTS AT GROUND LEVEL.

- EVEN WITH CONSERVATIVE APPROACH ANTICIPATED DAMAGE CATEGORY IS 1) - VERY SLIGHT.

check basal heave
F.O.S



Box 2.5
+ figure 2.18
etc.

Figure 2.14 *Procedure for prediction of wall deflections and ground surface movements*

Estimates of wall deflections and associated ground surface movements should follow the procedure shown in Figure 2.14. Case-history-based empirical methods of prediction are to be preferred to use of complex analyses, unless such analyses are first "calibrated" against reliable measurements of well-monitored comparable excavations and wall systems. Table 2.
to estimate *ground surface movements a*
clay. Figure 2.12 can be used for walls
estimates of *wall deflection* can be obtai
Appendix 2. This will depend upon the
against base heave. System stiffness is d
CIRIA publication C517 (1999), Append
base stability.

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1).

WALL INSTALLATION - INDUCED GROUND MOVEMENT.

MOST AKIN TO DIAPHRAGM TECHNIQUE FOR UNDERPIN CONSTRUCTION

BUT TRENCH SHEETING SIMILAR TO SHEET PILING.

TAKE WORST CASE FROM TABLE 2-2

NOTE - APPLIES TO STIFF CLAY.
SITE CONDITION IS MADE GROUND ONTO CLAY
⇒ NOT EQUIVALENT.

SURFACE MOVEMENT AT WALL

$\frac{\delta hi}{D} = 0.04 + 0.05 = 0.09\%$ at 0D spacing

for 1.5D from excavation.

$\frac{\delta vi}{D} = 0.04 + 0.05 = 0.09\%$ at 0D spacing

for 2D from excavation.

Spacing	$\delta hi/D$ %	$\delta vi/D$ %	
0D	0.09	0.09	
0.5D	0.055	0.045	
1.0D	0.025	0.02	
1.5D	0	0.008	
2.0D	0	0	

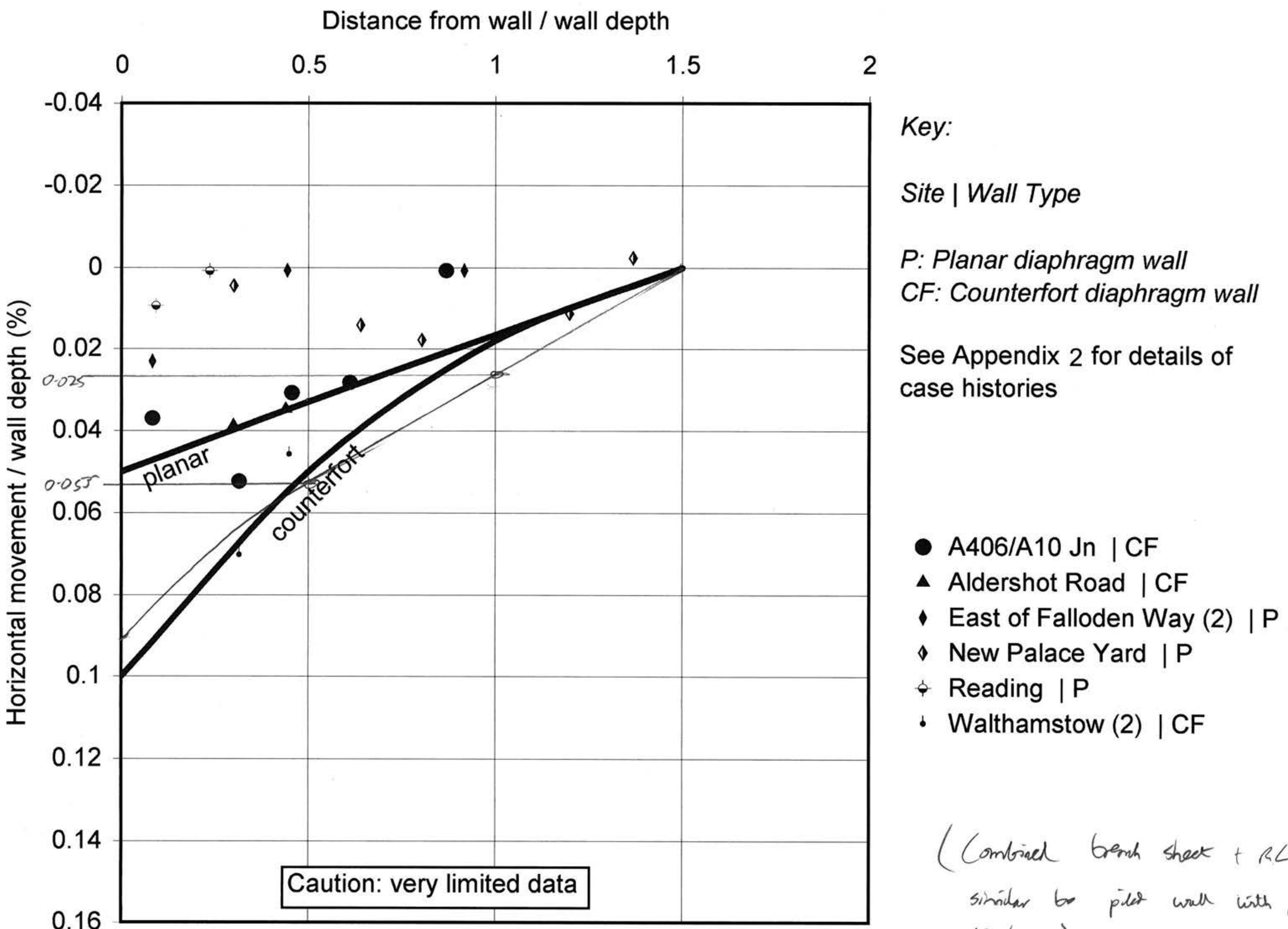

Fig 2-9 **(a)** Horizontal movements

(Combined trench sheet + RC wall similar to piled wall with planar diaphragm)

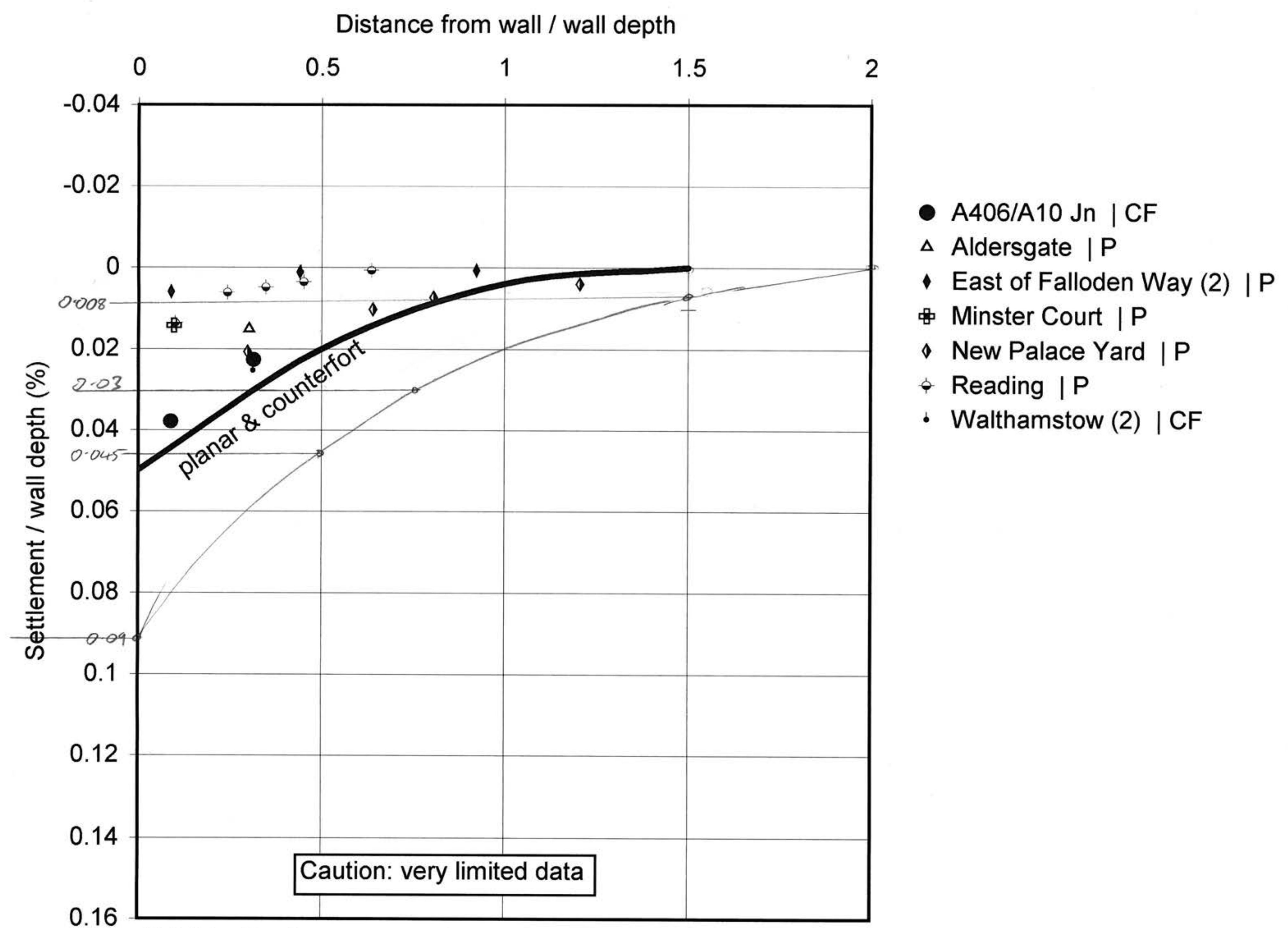

Fig 2·9 **(b)** Vertical movements

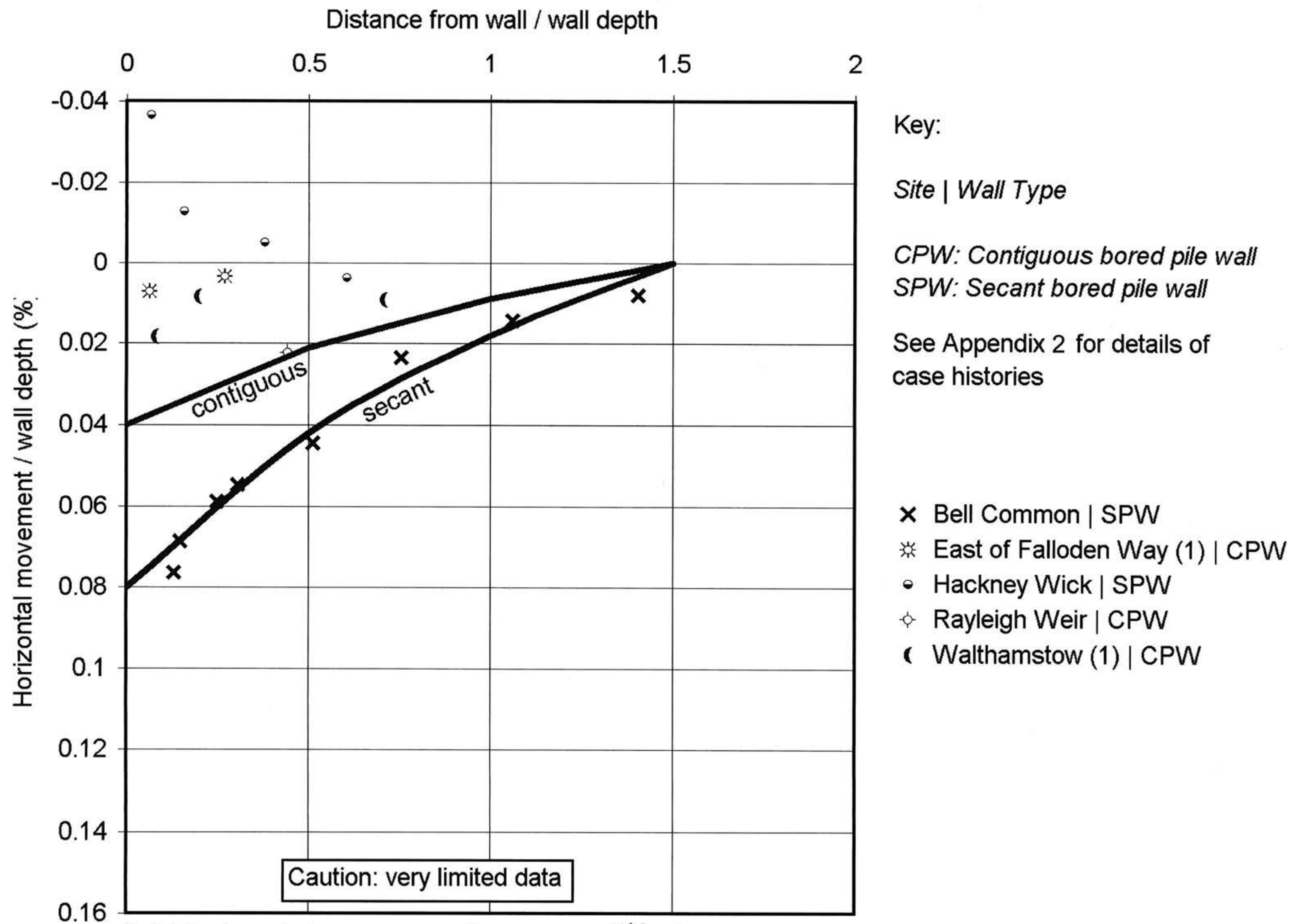

Fig 2-8 **(a)** Horizontal movements in stiff clay

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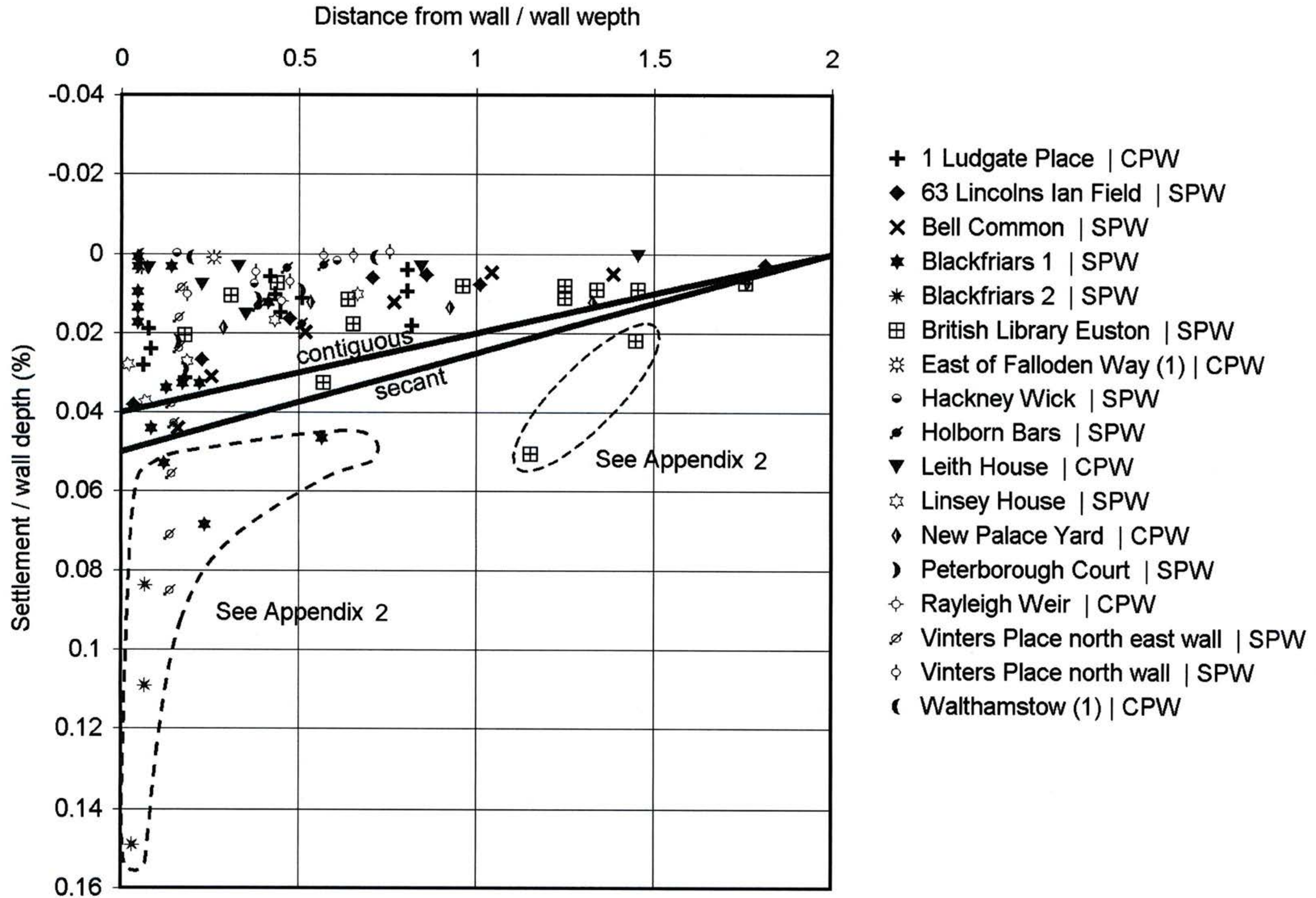

Fig 2.8 **(b)** Vertical movements in stiff clay

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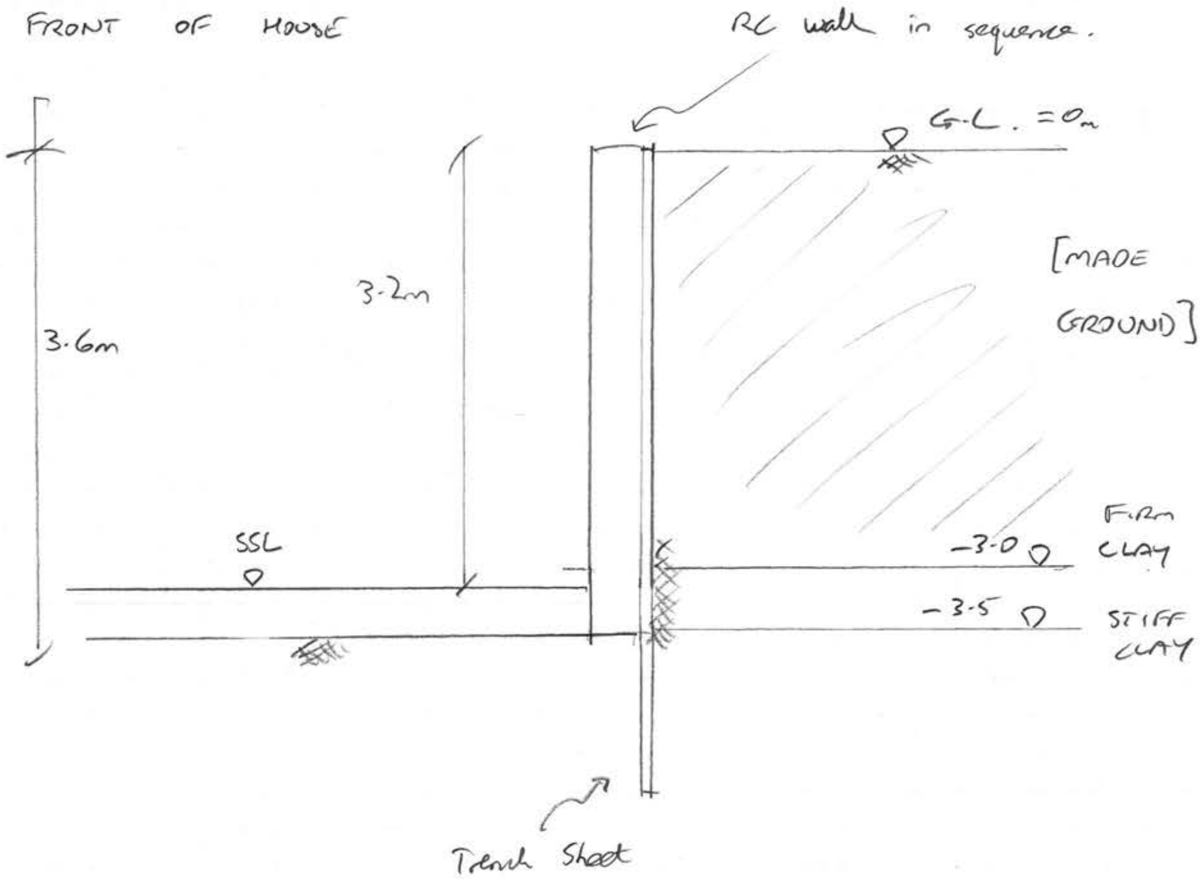
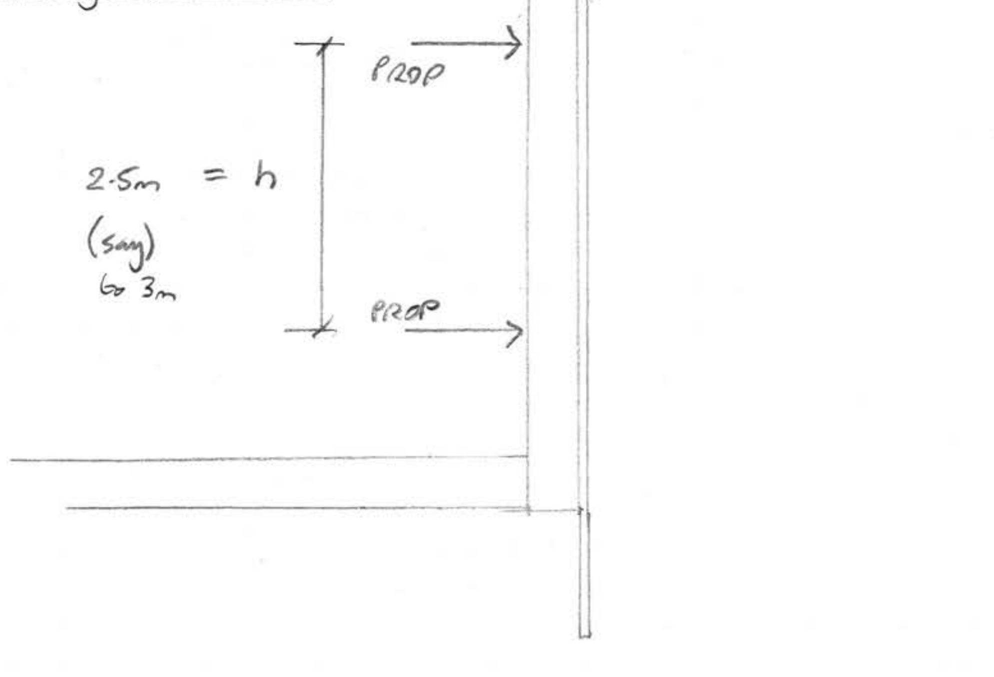
2)



Temporary Construction



	TRENCH SHEET	CONCRETE WALL
E	205 GPa	24 GPa
I	119.7 cm^4/m	225 000 cm^4/m $= \frac{30^3 \times 100}{12}$
h	2.5m	3m
γ_w (saturated).	18 kN/m^3	18 kN/m^3

$\rho_s = \frac{EI}{\gamma_w h^4}$

$\Rightarrow \rho_s = 0.349$ N/m per m

if $h = 2$m

$\rho_s = 0.852$ N/m per m

$\rho_s = 37$ N/m per m (concrete wall)

if γ_w = water only (10kN/m^3)

then

$\rho_s = 0.628$ N/m per m ($h = 2.5$m)

1.53 N/m per m ($h = 2$m)

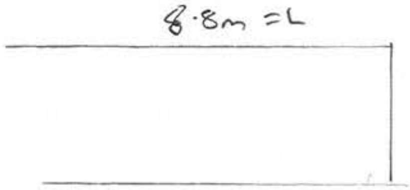
$\rho_s = 67$ N/m per m (concrete wall)

BASE HEAVE STABILITY

(TOMLINSON 9.7)

$D_c = \frac{N_c s}{\gamma}$ $s = c_w =$ min 4.5N = 86 kPa.

$N_c = 6.2$



$D = 1.6m$

Shape 1

$B/L = 0.57$ $D/B = 0.32$

Shape 2

$D = 3.6m$

$B/L = 0.4$ $D/B = 1.8$

$N_c = 7.5$

$\Rightarrow D_c = \frac{6.2 \times 86}{18} = 30m.$

$F = \frac{N_c s}{\gamma D + P} = \frac{6.2 \times 86}{18 \times 3.5 + 10} = 7.3 > 3$ ✓ ok.

3) HORIZONTAL WALL DEFLECTION:

SECTION A2-3

Figure A2-2 b) for F.O.S = 3.0

if $\rho = 67$ $\frac{\delta_{h max}}{D} = 0.25\%$

$\rho = 36$ $\frac{\delta_{h max}}{D} = 0.36\%$

Figure A2-1

for $\frac{\delta_{h max}}{D} = 0.36\%$ $\delta_h = 10mm$ for $D = 3.0m$

$= 12 mm$ for $D = 3.6m$.

0.25% $\delta_h = 7.5mm$ for $D = 3.0m$.

(below ground level)

Figure 2.13

For F.O.S. = 7.3

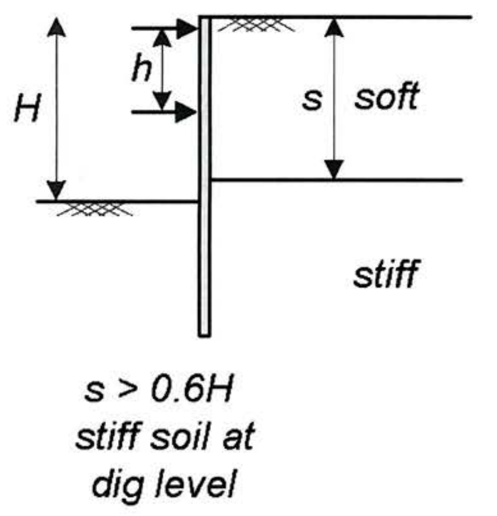
$\frac{\delta_{h max}}{D}$ approaches 0.1% for $\rho = 30$ to 70

$\boxed{\Rightarrow \text{take } \frac{\delta_{h max}}{D} = 0.20\%}$

3) SECTION A2-3

if $\rho = 67$ $\frac{\delta_{hmax}}{D} = 0.25\%$

if $\rho = 36$ $\frac{\delta_{hmax}}{D} = 0.36\%$



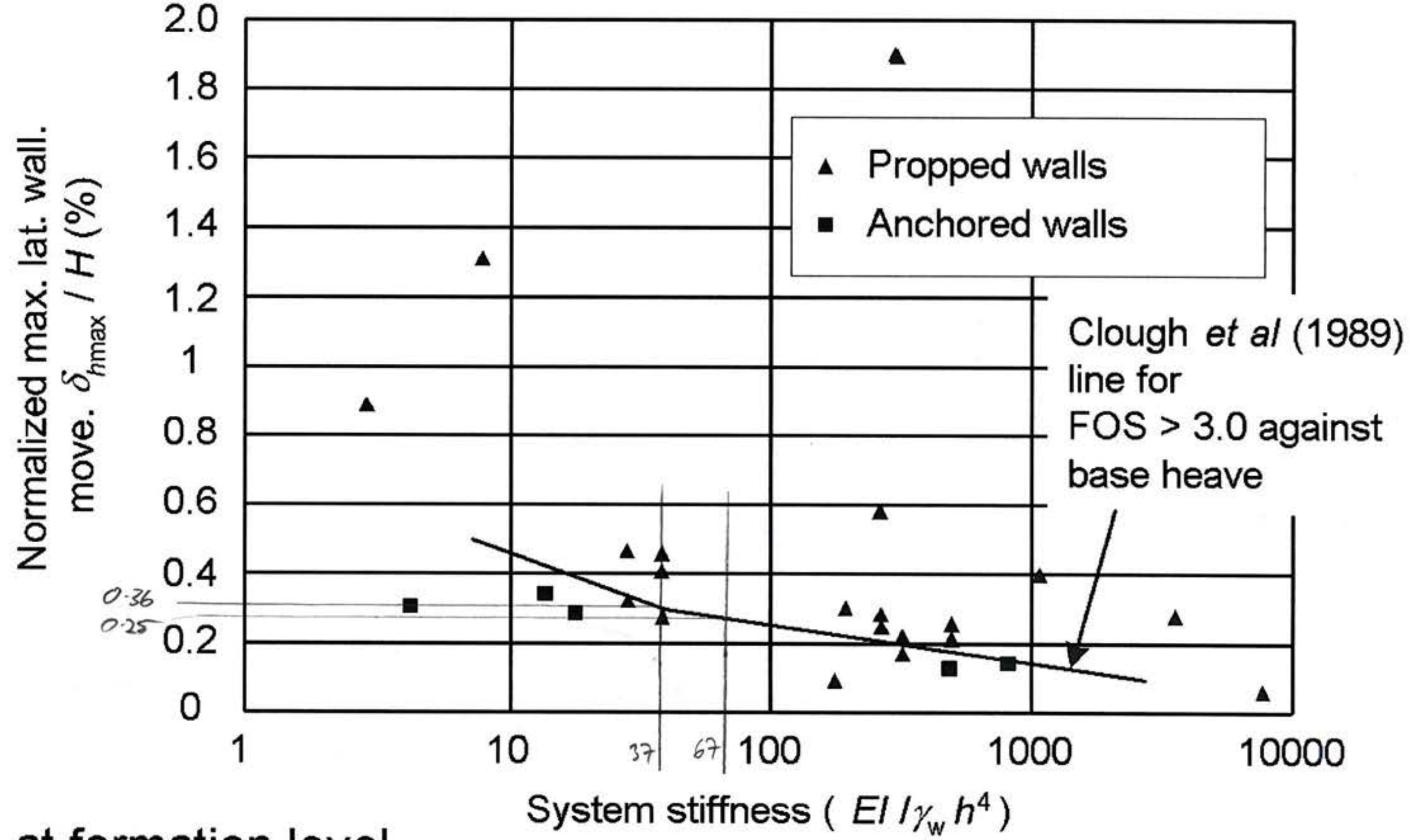


Figure A2.2
(b) Walls with s>0.6H - stiff soil at formation level

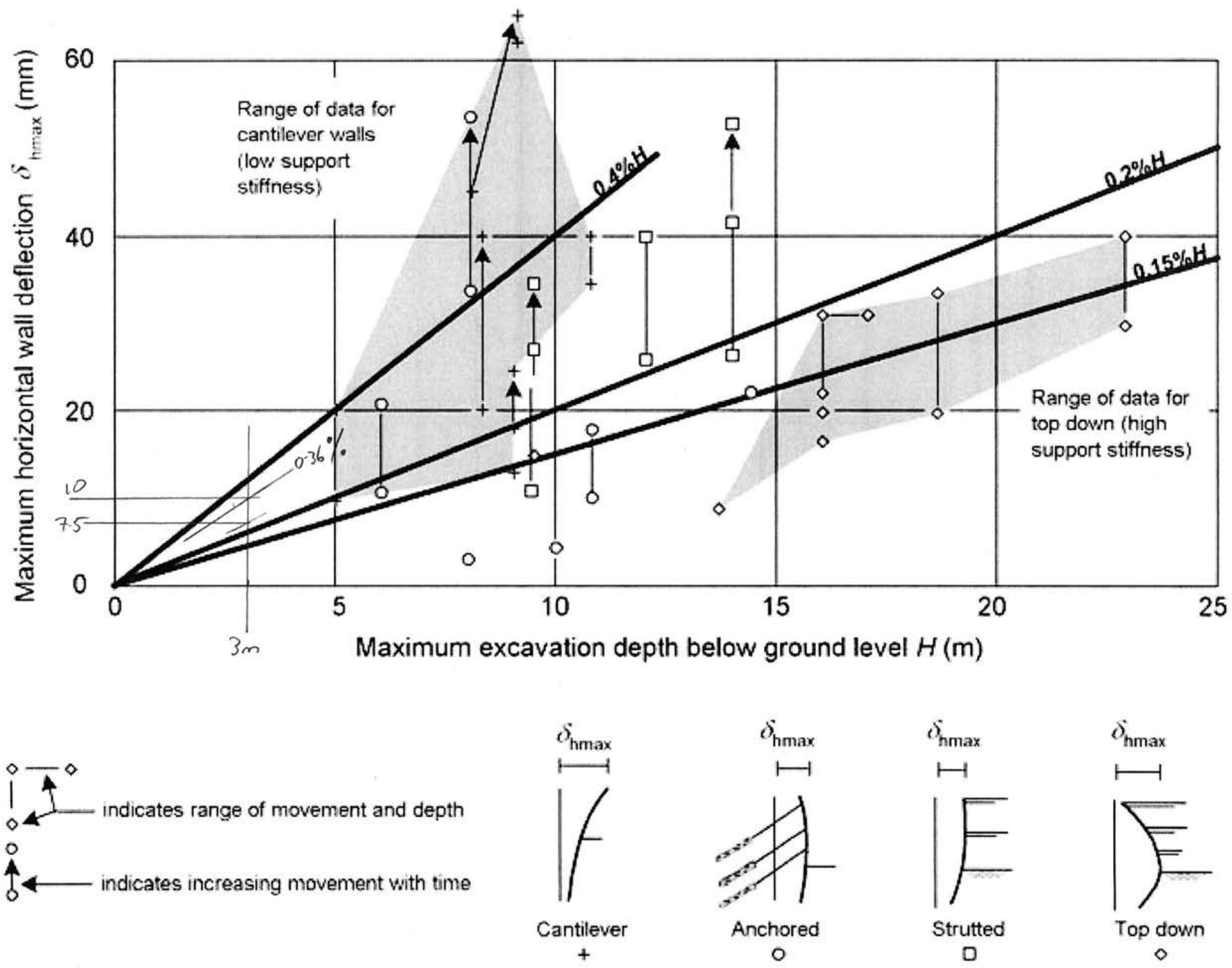


Figure A2.1 *Observed maximum lateral wall deflections for excavations in London Clay (after St John* et al, *1992)*

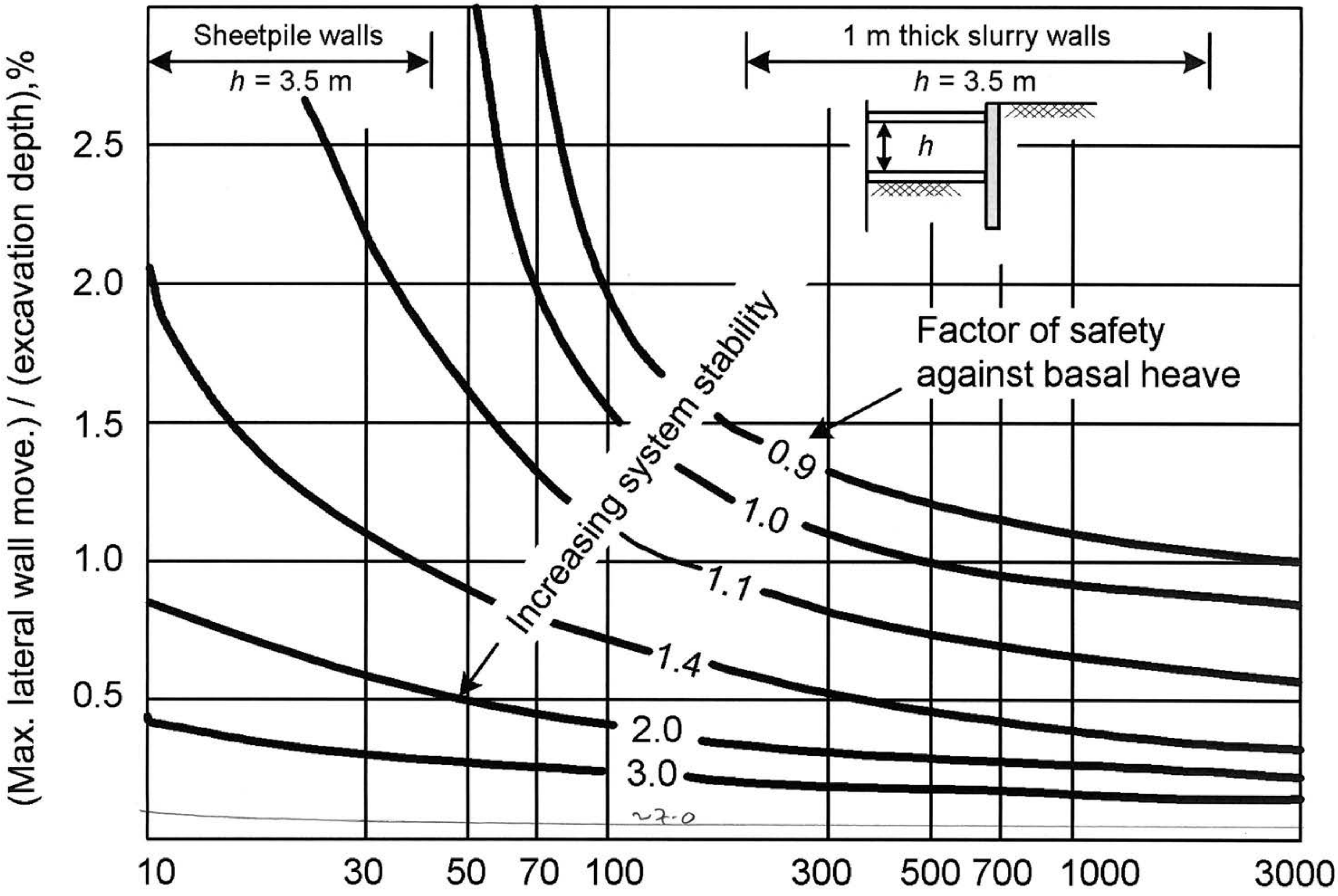


Figure 2.13 *Maximum lateral wall movement versus system stiffness (after Clough* et al, *1989)*

3-4

4) VERTICAL GROUND MOVEMENT

Figure 2.11a horizontal movements

for $\frac{\delta h_m}{D} = 0.2$ at wall

line plotted to $\delta h_m = 0$ at 4D away.

$\Rightarrow$ at D away $\frac{\delta h}{D} = 0.15\%$

at 2D away $\frac{\delta h}{D} = 0.10\%$

3D $\frac{\delta h}{D} = 0.05\%$

4D $\frac{\delta h}{D} = 0$.

Figure 2.11b vertical movements.

for 0.6D away $\frac{\delta v}{D} = 0.12\%$

1D $\frac{\delta v}{D} = 0.105\%$

2D $\frac{\delta v}{D} = 0.06\%$

3D $\delta v/D = 0.024\%$

3.7D $\frac{\delta v}{D} = 0$

at 0D $\frac{\delta v}{D} = 0.11\%$

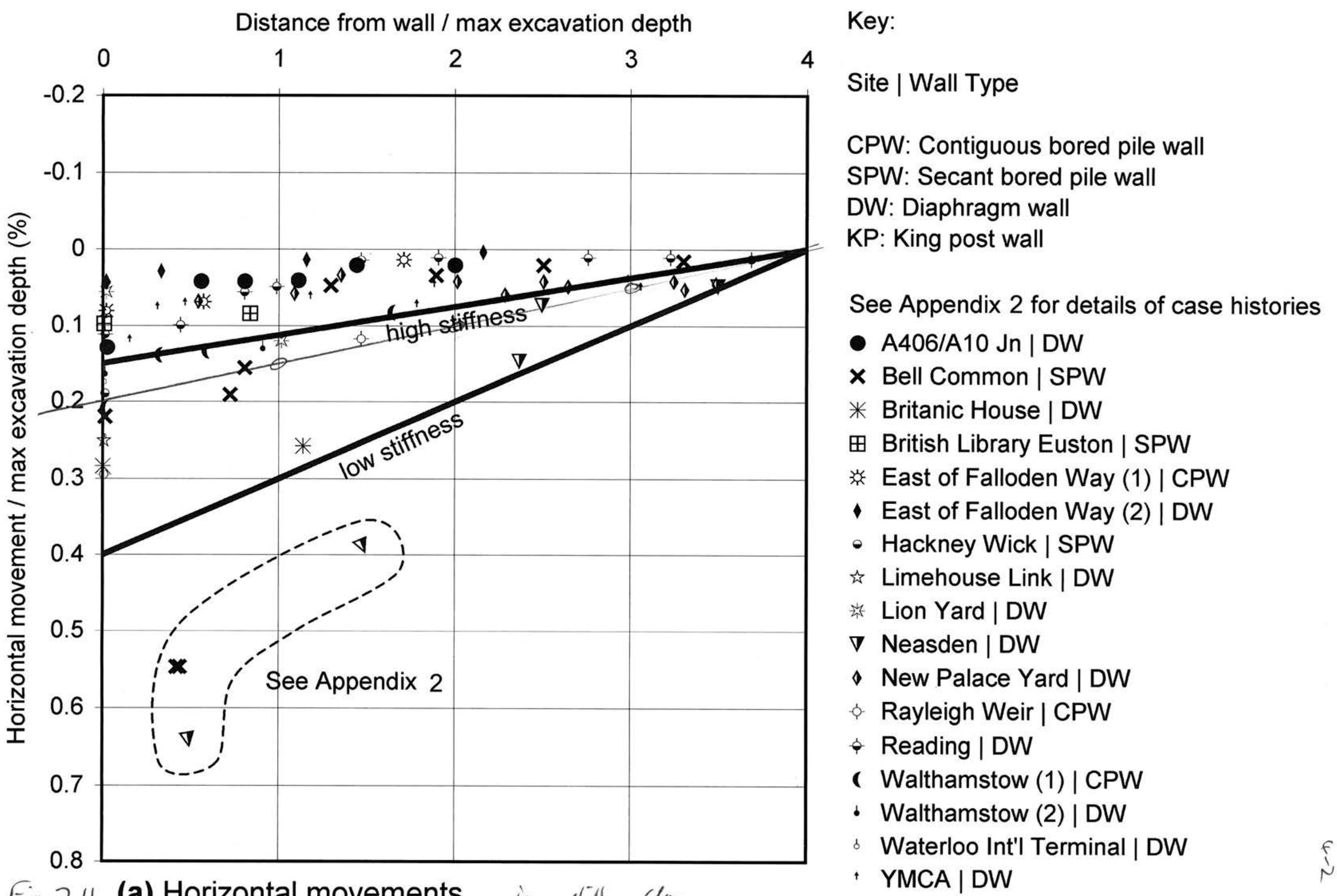


Fig 2.11 **(a)** Horizontal movements in stiff clay

4-2

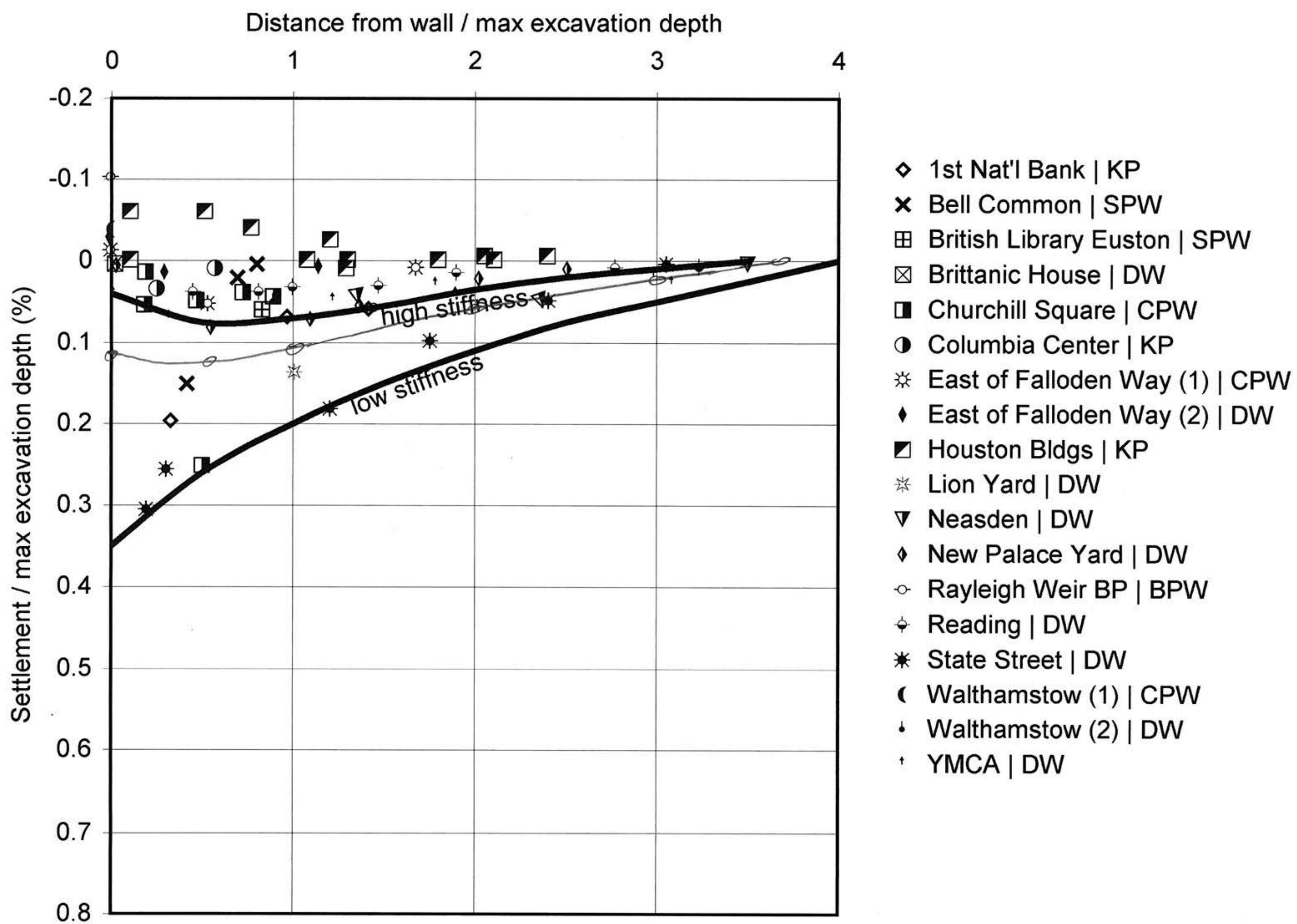


Fig 2-11 **(b)** Vertical movements in stiff clay.

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5) TOTAL GROUND MOVEMENT:

Spacing	σ_v tot	σ_h tot
0D	0.2%	0.29%
0.5D	0.16%	0.23%
1.0D	0.125%	0.17%
1.5D	0.081%	0.125%
2.0D	0.06%	0.10%
3.0D	0.024%	0.05%
3.7D	0	0.025%
4.0D	0	0

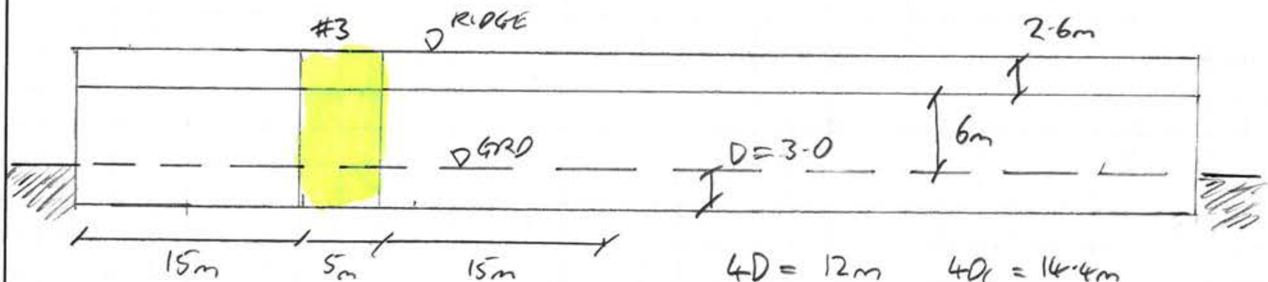
7) DAMAGE CATEGORY ASSESSMENT

i) STRUCTURE L AND H:

MID TERRACE OF 14 houses (one double width)

house width ≃ 5m

⇒ total length = 75m



$4D = 12m$ $4D_f = 14.4m$

max L_1 affected = 35m.

ELEVATION

H varies. 6m at eaves to front garden (GRD)
8.6m at ridge to front garden (GRD)

7.6m at eaves to existing LG }
10.2m at ridge to existing LG. } beneath house.

DEPTH OF HOUSE FRONT - BACK

L_2 = 8m (main house)

L_3 = 15.4m (rear wing + main house).

7ii)

Symmetric profile E/S along terrace.

$$\Rightarrow \Delta = \sigma_v \max = 0.2\% \times D = 6mm \quad \text{for } D = 3m$$

$$7.2mm \quad \text{for } D_f = 3.6m$$

$$\Rightarrow \Delta / L = \frac{7.2}{35000} = 0.021\%$$

$$L_1 / H = \frac{35}{6} = 5.83 \quad \text{(front facade)}$$

to rear (NB conservative as omits depth of existing undercroft and shallow excavations beneath the main house).

$$\Delta / L = \frac{7.2}{15400} = 0.047\% \qquad 15.4 = 4D.$$

$$L_3 / H = \frac{15.4}{10.2} = 1.5 \quad \text{(ridge to existing LG)}$$

$(0.2 - 0.05)\% D.$

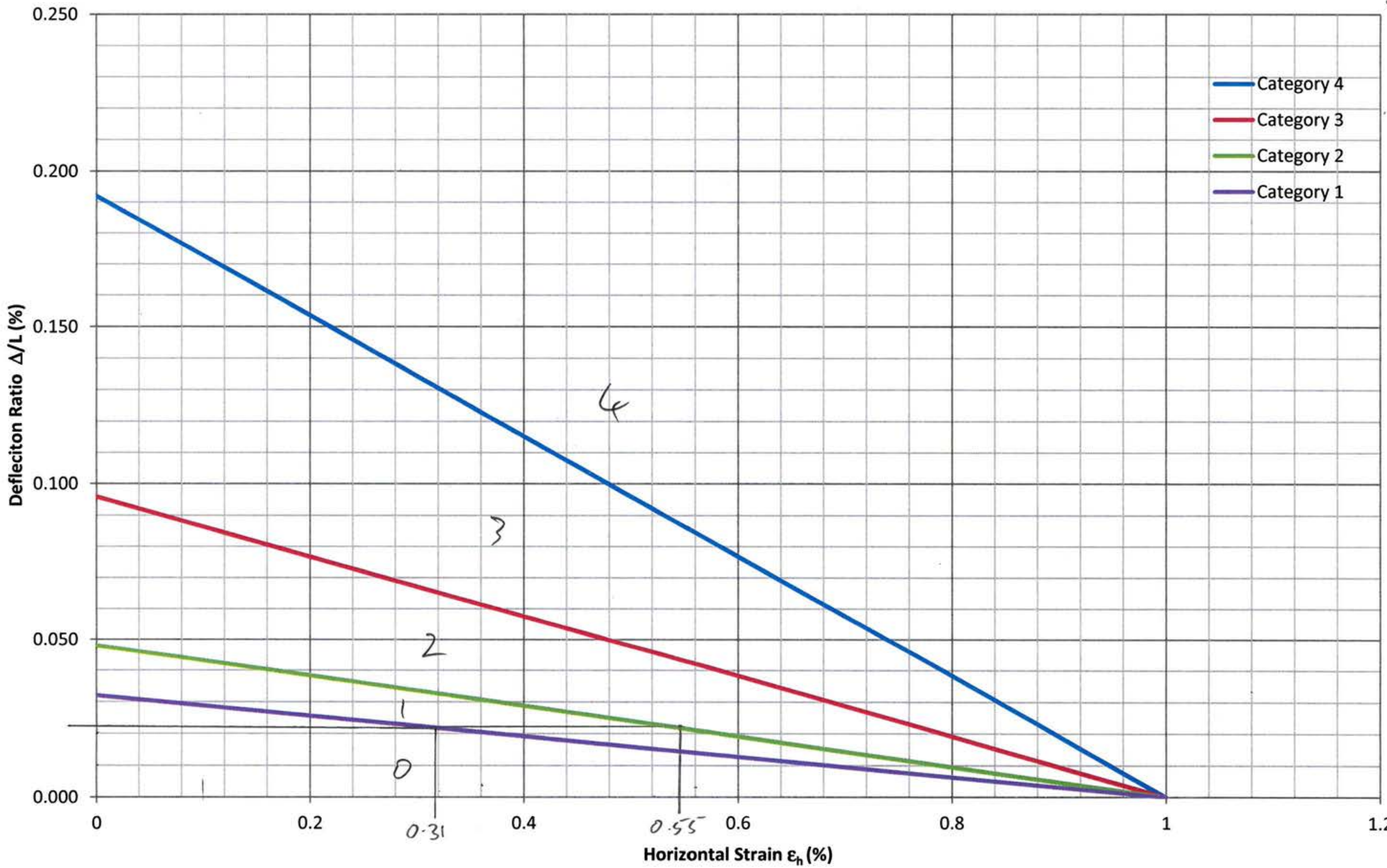
$$\Delta / L = \frac{5.4}{8000} < 0.068\% \qquad 8 = 2.2D$$

$$L_2 / H = \frac{8}{10.2} = 0.78 \quad \text{(ridge to existing LG).}$$

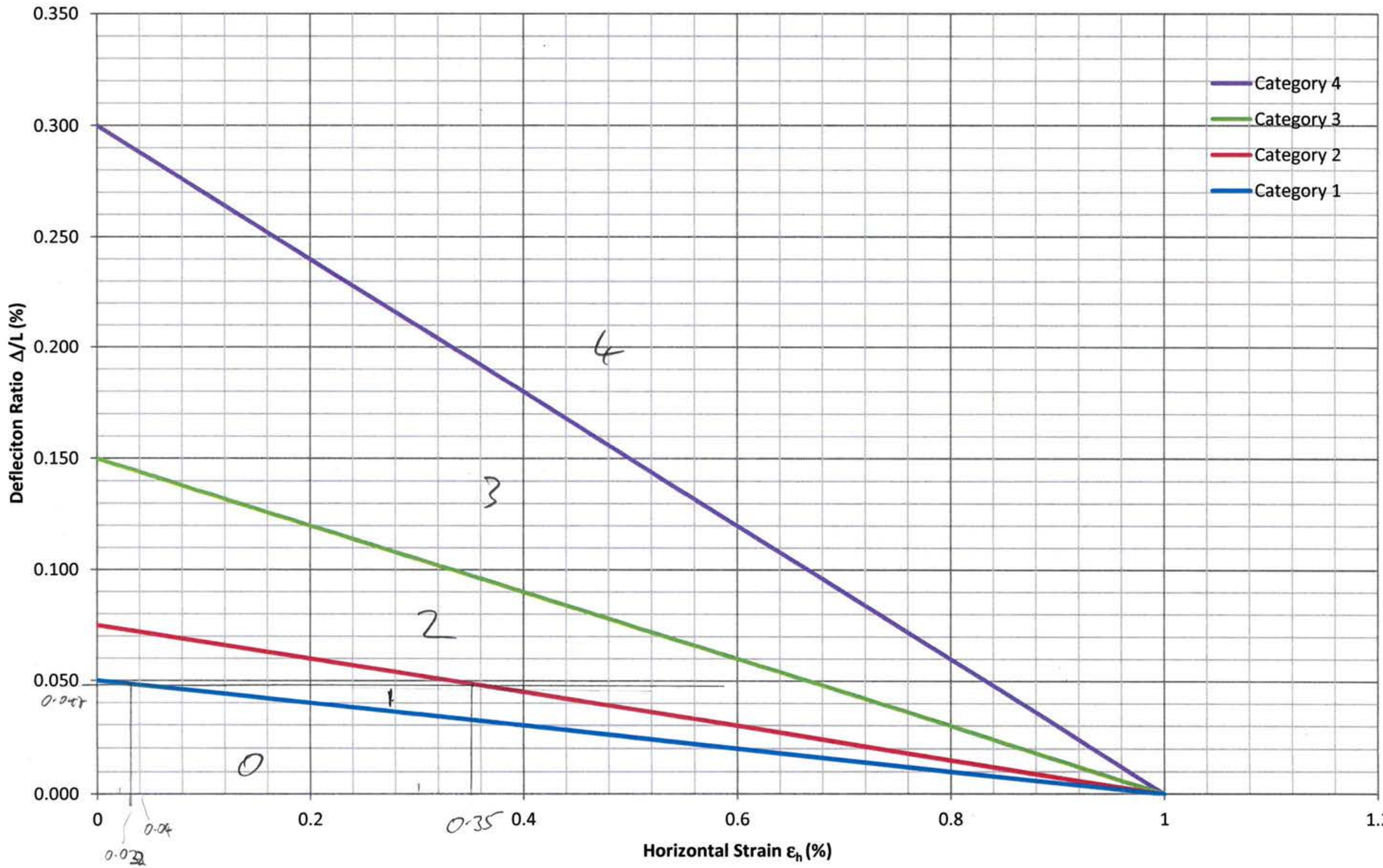
7-3

7(iii))

Burland Damage Category for Deflection vs Horizontal Strain in Hogging for L/H = 4.0

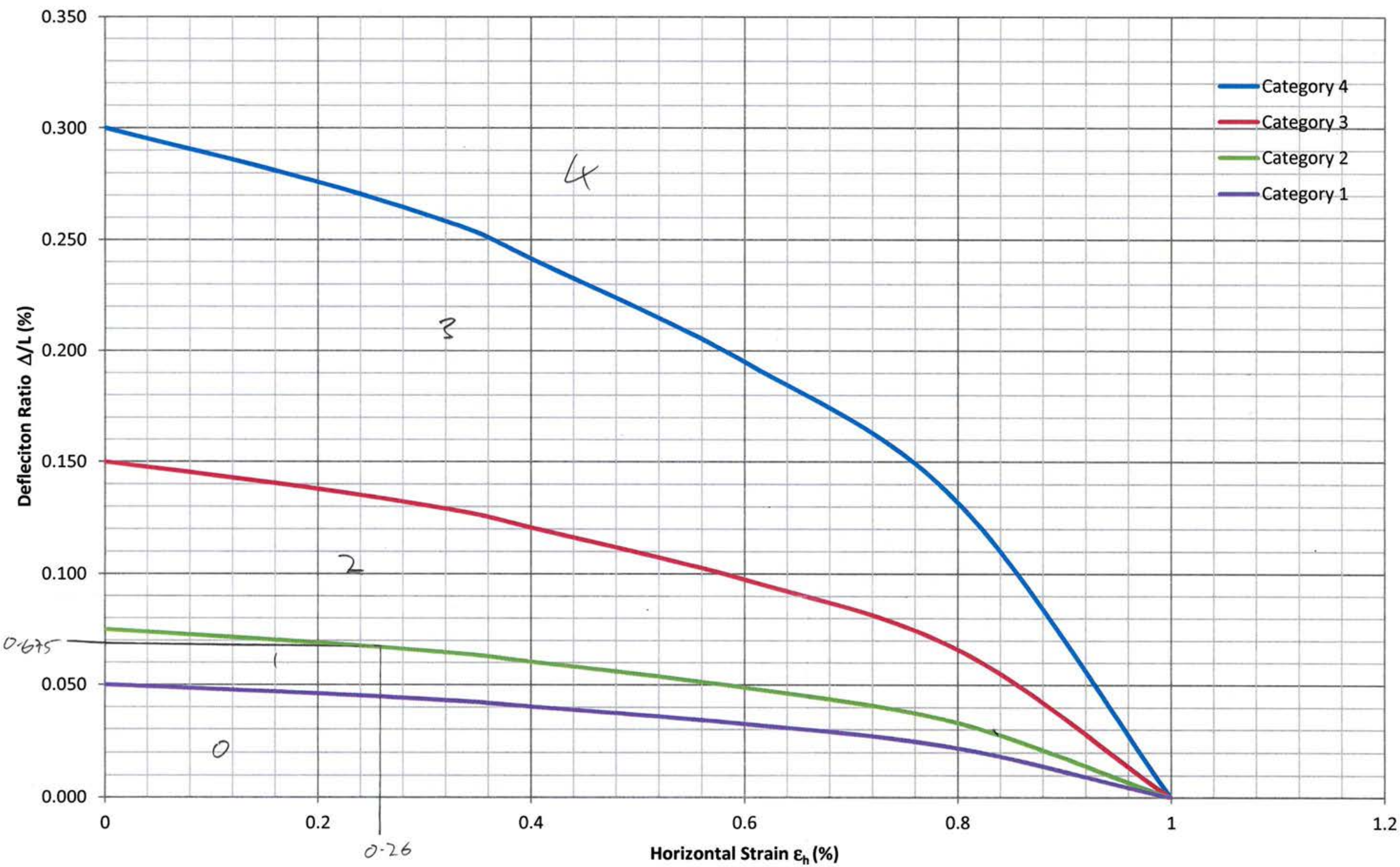


Burland Damage Category for Deflection vs Horizontal Strain in Hogging for L/H = 1.5



7-4

Burland Damage Category for Deflection vs Horizontal Strain in Hogging for L/H = 0.5



7iv) – v)

FROM INTERACTION PLOTS (SIMILAR TO Fig 2.18c in C580)

For $L/H = 5.8$ (SIMILAR CURVE TO $L/H = 4$)

$\varepsilon_h = 0.31\%$ limit for category 0 with $\Delta/L = 0.021\%$

$\varepsilon_h = \dfrac{\delta_h}{L} = \dfrac{0.29\% \times D}{35\,000} = 0.03\%$ ⇒ category 0.

Along terrace

For $L/H = 1.5$

$\varepsilon_h = 0.032\%$ limit for category 0 with $\Delta/L = 0.047\%$
0.35% limit for category 1

$\Rightarrow \varepsilon_h = \dfrac{\delta_h}{L} = \dfrac{(0.29 - 0.05)\%\ D}{10.2} = 0.085\%$ ⇒ category 1

Front – Rear. inc extension

For $L/H = 0.78$ use $L/H = 0.5$

$\varepsilon_h = 0.26\%$ limit for category 1.

$\varepsilon_h = \dfrac{\delta_h}{L} = (0.29 - 0.09) = 0.2\%$ ✓ ok ⇒ category 1

Front – rear of main house

7vi)
Conclusion

Damage category 1 anticipated to CIRIA C580
+ Burland Scale $\Rightarrow$ $\varepsilon_h < \varepsilon_{lim} = 0.075\%$