CampbellReith
consulting engineers

3 Aldred Road
London NW6 1AN

Basement Impact Assessment Audit

For

London Borough of Camden

Project Number: 12066-60
Revision: F1

February 2016

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Document History and Status

Revision	Date	Purpose/Status	File Ref	Author	Check	Review
D1	23/10/15	Comment	PCDjw12066-60-231015-3 Aldred Road-D1 .doc	P C Daniels	E M Brown	E M Brown
D2	19/01/16	Comment	PCDjw12066-60-180116-3 Aldred Road-D2 .doc	P C Daniels	E M Brown	E M Brown
F1	29/02/2016	For planning	PCDjw12066-60-290216-3 Aldred Road-F1 .doc	P C Daniels	E M Brown	E M Brown

Document Details

Last saved	29/02/2016 17:10
Path	PCDjw12066-60-290216-3 Aldred Road-F1 .doc
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Project Number	12066-60
Project Name	3 Aldred Road, London NW6 1AN
Planning Reference	2015/3109/P

Contents

Appendix

1.0 NON-TECHNICAL SUMMARY

1.1. CampbellReith was instructed by the London Borough of Camden (LBC) to carry out an audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 3 Aldred Road, London NW6 1AN - Planning Reference 2015/3109/P.

1.2. CambellReith accessed the LBC Planning Portal and reviewed the latest revisions of submitted documentation against an agreed audit check list.

1.3. The Audit reviewed the BIA for potential impacts on land stability and local surface and groundwater conditions arising from the proposed basement development in accordance with LBC's policies and technical procedures.

1.4. Subsequent to the issue of the above initial and revised audit reports, a number of clarifications and confirmations have been received. This final audit constitutes a revision to the original reports, amended as necessary, to accommodate the clarifications and confirmations received.

1.5. A revised BIA has not been formally issued but the original BIA will be construed by CampbellReith as having been amended in accordance with the contents of the above additional documentation. Any references in this audit to the revised BIA shall be taken as a reference to the original BIA updated as above.

1.6. The revised BIA has not been taken beyond the screening stage as defined in the LBC Planning Guidance document 'Basements and Lightwells' (CPG4), dated July 2015. However, it is confirmed that the original and supplementary documents adequately identify the potential impacts to stability and the water environment.

1.7. The qualifications of the authors, checkers and approvers of the revised BIA are in compliance with the requirements of CPG4.

1.8. The proposed basement works comprise the deepening of the existing underground spaces by 1.315m. However, the extended basement will be founded 3.5m or so below the level of the front garden paving. It has been confirmed that the adjoining properties are underlain by a basement or an undercroft.

1.9. Ground conditions at the site have been confirmed to comprise Made Ground to 3m bgl, overlying London Clay. A perched water table is anticipated in the Made ground.

1.10. The revised BIA has recommended that due to the potential for perched water in the Made Ground, waterproofing should be installed to the basement and that provision should be made for local dewatering during construction. This is accepted.

1.11. The revised BIA has confirmed that although the London Clay is the shallowest 'natural' stratum at the site, the stratum occurs at depth and there is no evidence of shrink/swell effects in local buildings. Also, there are no significant trees along the street frontage or in the back garden to the property. Nevertheless, a check will be made during basement excavation for any signs of desiccation.

1.12. The revised BIA has confirmed that following remedial works to drainage systems in Camden, Aldred Road is now not considered to be at risk of surface water flooding.

1.13. Basic structural calculations have been provided in the revised BIA for the RC basement walls. No calculations and/or information on propping arrangements have been provided. However, the revised BIA has confirmed that information on construction sequencing, ground movement monitoring, action trigger levels, contingency provisions etc. will be provided in compliance with the requirements of the Party Wall Act. This is accepted.

1.14. A ground movement and building damage assessment has confirmed that the category of building damage due to basement construction is not anticipated to exceed Burland Category 1. This is accepted on the assumption that there will be good control of workmanship and the affected buildings are in sound condition.

1.15. An indicative programme has been submitted in the revised BIA.

1.16. Queries and requests for clarification/further information, all of which have been satisfactorily addressed, are summarised in Appendix 2.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by the London Borough of Camden (LBC) on 29 September 2015 to carry out a Category 'A' Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 3 Aldred Road, London NW6 1AN - Planning Reference 2015/3109/P.

2.2. The Audit was carried out in accordance with the Terms of Reference set by the LBC. The Audit reviewed the BIA for potential impacts on land stability and local surface and groundwater conditions arising from the proposed basement development in accordance with the LBC's policies and technical procedures.

2.3. Subsequent to the issue of the above initial audit, a number of clarifications and confirmations have been issued. This current audit constitutes a revision to the original CampbellReith audit, amended as necessary, to accommodate the clarifications and confirmations received.

2.4. A revised BIA has not been formally issued, but the original BIA will be construed by CampbellReith as having been amended in accordance with the contents of the above additional documentation. Any references in this audit to the revised BIA shall be taken as a reference to the original BIA updated as above.

2.5. A BIA is required for all planning applications with basements in the LBC in general accordance with policies and technical procedures contained within the following documents:

a) Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.

b) Camden Planning Guidance (CPG) 4: Basements and Lightwells.

c) Camden Development Policy (DP) 27: Basements and Lightwells.

d) Camden Development Policy (DP) 23: Water.

2.6. The BIA should demonstrate that schemes:

a) Maintain the structural stability of the building and neighbouring properties.

b) Avoid adversely affecting drainage and run off or causing other damage to the water environment; and,

c) Avoid cumulative impacts upon structural stability or the water environment in the local area.

The BIA should evaluate the impacts of the proposed basement considering the issues of land stability, hydrology and hydrogeology via the process described within the GSD and should make recommendations for detailed design.

2.7. The LBC Audit Instruction described the planning proposal as '*Single storey side and rear extension to lower ground floor; creation of habitable space within existing void below the main building and lowering of ground level; first floor rear extension; alterations to openings'.*

The Audit Instruction noted the following:

a) The basement proposals do not involve a listed building nor does the site neighbour any listed buildings.

b) The site is not in an area subject to slope stability constraints or subterranean (groundwater) flow constraints but is in an area subject to surface water flow and flooding.

c) It is unknown whether the application requires determination by the Development Control Committee (DCC).

d) The scope of the submitted BIA does not extend beyond the screening stage.

2.8. CampbellReith originally accessed the LBC Planning Portal on 21 October 2015 and examined the following reports and drawings relevant to the audit:

a) A 'Ground Investigation (GI) Report' prepared by Aviron Associates Ltd (AAL), dated 01 July 2015.

b) A separate 'Trial Pit and Photographs' Report prepared by AAL, dated 01 July 2015.

c) A 'Basement Impact Assessment Screening Summary' prepared by Price & Myers, Consulting Engineers (P&M), dated July 2015.

d) The following planning application drawings:

Site location plan.

Existing ground and basement (lower ground) plans.

Proposed ground and basement (lower ground) plans.

Existing front and rear elevations.

Proposed front and rear elevations.

Section 'A-A' existing and proposed.

2.9. An updated audit report (rev D2), based upon a review of documents issued on 11 December 2015, was issued on 18 january 2016. Those documents comprised the following:

a) A document entitled 'Design Team Audit Query Responses', prepared by P&M.

b) A sketch entitled 'Indicative Lightwell Construction Sequence', prepared by P&M.

c) Retaining Wall Structural Calculations (RW1) - Temporary Condition, prepared by P&M.

d) A Preliminary Construction Programme, prepared by Pawlik + Wiedmer.

e) A revised 'Ground Investigation (GI) Report' prepared by AAL, dated 09 December 2015.

2.10. A few queries remained to be addressed and a further tranche of information was received on 10 February 2016 in response to the revised audit report. That information, which included revised and additional calculations and details of neighbouring basements, has been reviewed within this final audit report and is presented in Appendix 3.

2.11. No comments were received from the public on the planning application relating to land stability, hydrology or hydrogeology.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are the BIA author(s) credentials satisfactory?	Yes	
Is data required by Cl.233 of the GSD presented?	Yes	
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrology and hydrogeology?	Yes	
Are suitable plans/maps included?	Yes	
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	
Slope and Ground Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Information on the presence of adjacent basements/undercrofts provided in February 2016 – refer to Appendix 3.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	
Hydrogeology (Groundwater Flow) Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	
Is a conceptual ground model presented?	Yes	

Item	Yes/No/NA	Comment
Slope and Ground Stability Scoping Provided? Is scoping consistent with screening outcome?	No	The BIA does not extend beyond the screening stage. However, a GMA and building damage assessment were presented in February 2016 – refer to Appendix 3.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	No	The BIA does not extend beyond the screening stage. However, it is accepted that the proposed development is not at risk of causing increased downstream surface water flooding.
Hydrogeology (Groundwater Flow) Scoping Provided? Is scoping consistent with screening outcome?	No	The BIA does not extend beyond the screening stage. However, it is accepted that the proposed basement works should not create any significantly increased barrier to groundwater flow.
Is factual ground investigation data provided?	Yes	
Is monitoring data presented?	Yes	
Is the ground investigation informed by a desk study?	Yes	However, a copy of the desk study has not been made available.
Has a site walkover been undertaken?	Yes	
Is the presence/absence of adjacent or nearby basements confirmed?	No	No information has been supplied on the presence or otherwise of adjacent basements. This information should be provided.
Is a geotechnical interpretation presented?	Yes	A limited geotechnical interpretation is provided within the GI report together with generalised engineering recommendations.

Item	Yes/No/NA	Comment
Does the geotechnical interpretation include information on retaining wall design?	Yes	But limited only.
Are reports on other investigations required by screening and scoping presented?	NA	No such reports were identified as being required.
Are baseline conditions described, based on the 'Guidance for Subterranean Development (GSD)'?	Yes	
Do the base line conditions consider adjacent or nearby basements?	Yes	Refer to Appendix 3.
Is an Impact Assessment provided?	Yes	A GMA and building damage assessment have been undertaken to assess the likely building damage category for the adjacent properties.
Are estimates of ground movement and structural impact presented?	Yes	A GMA and building damage assessment have been undertaken to assess the likely building damage category for the adjacent properties.
Is the Impact Assessment appropriate to the matters identified by screen and scoping?	Yes	As above.
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	Yes	
Has the need for monitoring during construction been considered?	Yes	

Item	Yes/No/NA	Comment
Have the residual (after mitigation) impacts been clearly identified?	Yes	
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	Yes	
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	
Does the BIA report state that damage to surrounding buildings will be no worse than Burland Category 2?	Yes	
Are non-technical summaries provided?	Yes	

4.0 DISCUSSION

4.1. The revised BIA has not been taken beyond the screening stage as defined in the LBC Planning Guidance document 'Basements and Light wells (CPG4)', dated July 2015.

4.2. The qualifications of the authors, checkers and approvers of the revised BIA are in compliance with the requirements of CPG4.

4.3. 3 Aldred Road is located on the western side of Aldred Road, West Hampstead. The property forms part of an extended north-west/south-east trending terrace and is situated between N^{o} 2 Aldred Road to the south and N^{o} 4 Aldred Road to the north. The property has a rear courtyard garden and a small paved frontage. There are no significant trees along the street frontage or in the back garden.

4.4. The property comprises a two-storey, brick-built, terraced house with a lower ground floor. The lower ground floor is of variable height, providing liveable space in the rear half of the property where ground levels are lower, a restricted height cellar towards the middle and a restricted height inaccessible void space towards the front. The top of lower ground floor slab in the cellar area lies some 1.6m below ground level (bgl).

4.5. A number of trial pits were sunk within the front half of the property to determine the nature and depth of the foundations. These were found to generally comprise corbelled brickwork footings bearing directly on the soil sub-stratum but set at a number of different levels.

4.6. The proposed basement works comprise the deepening of the existing cellar area and front void by 1.315m to habitable space dimensions and the extension of this new basement beyond the front elevation of the house below the existing paved garden frontage. The extended basement will be founded 3.5m or so below ground level and will be provided with roof lights.

4.7. No information has been supplied within the BIA on the presence or otherwise of adjacent basements. This information should be provided.

4.8. Ground conditions at the site have been confirmed from a single borehole/dynamic probe hole sunk to the front of the property in June 2015 to generally comprise soft to firm (becoming very soft) reworked clay (Made Ground) to 3m bgl, overlying firm (becoming firm to stiff) London Clay to 3.95m bgl, overlying stiff (becoming very stiff) London Clay.

4.9. A standpipe was installed in the above borehole to a depth of 5m bgl. Measurements made at the time of installation and subsequently in December 2015 following issue of the original CampbellReith Audit have confirmed the likelihood of perched water within the Made Ground.

4.10. With regard to issues of slope/ground instability, the BIA states that the site and wider area do not slope more than 7° (1:8) and that the proposed works will not alter this situation. The site also does not lie in the vicinity of railway cuttings and the like with a slope greater that 7°. On the basis of the above, there are no slope/ground stability concerns regarding the issues raised.

4.11. The BIA confirms that the London Clay is the shallowest 'natural' stratum at the site, locally overlain by Made Ground as noted above. The London Clay is known to be susceptible to shrink/swell effects and the stratum has been shown in the GI report to be of 'high volume change potential'. However, there are no significant trees local to the property and the revised BIA has confirmed that there is no evidence of shrink/swell effects in local buildings. Nevertheless, a check will be made during basement excavation for any signs of desiccation.

4.12. The BIA confirms that the site does not lie within 100m of a watercourse or potential springline, nor does it lie within 50m of Hampstead Heath ponds. A tributary of the River Westbourne was identified as running 200m to the south-east of the site but this will have been culverted many years ago and incorporated into the local sewer system. On the basis of the above, there are no stability issues arising from the basement being located in proximity to any of the water features discussed.

4.13. The BIA confirms that the site does not lie within an aquifer (the London Clay is relatively impermeable) and hence no significant dewatering will be required during excavation for the basement, thereby avoiding any associated settlement issues. However, the revised BIA has recommended that due to the potential for perched water in the Made Ground, waterproofing should be installed to the basement and that provision should be made for local dewatering during construction. This is accepted.

4.14. The BIA confirms that the basement will be constructed within 5m of the adjacent pedestrian right of way and highway. The revised BIA has clarified the potential need for services diversions and has set out the construction sequence envisaged in the front basement area with a view to maintaining the stability and integrity of the local infrastructure.

4.15. It is stated in the BIA that the proposed basement will not significantly increase the differential depth of foundations relative to neighbouring properties. Subsequent to the initial audit report, the architect confirmed that consultations with the neighbours had identified a basement to N° 2 Aldred Road and an undercroft to N° 4.

4.16. The BIA confirms the site does not lie over or within the exclusion zone of any tunnels.

4.17. Regarding surface water flow and flooding, the BIA confirms that the property does not lie within the catchment area of the ponds on Hampstead Heath and thus will have no influence on the water inflow to the ponds.

4.18. The BIA confirms that the areas of impermeable hardstanding to the front and rear of the property will remain as at present and that there will be no change to the route, profile or quality of surface water flows as a result of basement construction and thus no impact on downstream properties or watercourses.

4.19. In terms of flood risk, Aldred Road is listed as having been flooded in 2002. However, the revised BIA has confirmed that following remedial works to drainage systems in Camden, Aldred Road is not now considered to be at risk of surface water flooding. The basement also does not lie below/in the vicinity of any static water features.

4.20. Concerning subterranean (groundwater) flow impacts, the BIA confirms that the site does not lie directly above an aquifer, within 100m of a watercourse, well, pond or potential springline nor below a defined water table - although as noted above, there is expected to be a perched water table within the Made Ground. It is considered that the above, together with the apparently cohesive nature of the Made Ground will mean that any groundwater flow will be limited and basement construction is thus likely to have little impact on groundwater flow locally and on nearby structures.

4.21. The BIA confirms that as part of the site drainage, no more surface water than at present will be discharged to the ground and thus there will be no impact on groundwater flows or levels.

4.22. In terms of the form of basement construction proposed, the BIA states that the load-bearing walls to the existing property are to be sequentially underpinned with mass concrete to permit basement excavation. Reinforced concrete (RC) walls tied in to a new RC basement ground-bearing slab are to be incrementally constructed in front of the underpins to provide permanent lateral support to the underpins and create a habitable space. Temporary lateral support to the underpins is to be provided as necessary and the props removed as the permanent concrete works are completed.

4.23. Although basic structural calculations have been provided for the RC basement walls in the revised BIA, only preliminary information was provided with respect to propping arrangements. It is recommended that detailed design is undertaken by the selected contractor and agreed with the party Wall Surveyor. The original calculations contained errors, which have now been remedied.

4.24. Information provided in February has confirmed the neighbouring properties to have a basement or an undercroft, reducing the differential depth of foundations resulting from the basement proposals.

4.25. A Ground Movement and Building damage Assessment were provided in February based on the conservative assumptions of shallow neighbouring foundations and full depth excavation. It is

accepted that, on the assumption that there is good control of workmanship and the neighbouring properties are in sound condition, damage should not exceed Burland category 1.

4.26. It is essential, that once fully formulated, the designer's requirements regarding construction sequencing, propping, ground movement monitoring, action trigger levels etc. are fully specified in the contract documents for the works so that the contractor is made fully aware of the levels of compliance required. There should also be contingency provisions in place should on-going movements indicate the likely exceedance of predicted values. The revised BIA has confirmed that the above information will be provided in compliance with the requirements of the Party Wall Act.

4.27. An indicative programme has been submitted in the revised BIA.

5.0 CONCLUSIONS

5.1. The revised BIA has not been taken beyond the screening stage as defined in the LBC Planning Guidance document 'Basements and Lightwells' (CPG4), dated July 2015.

5.2. The qualifications of the authors, checkers and approvers of the revised BIA are in compliance with the requirements of CPG4.

5.3. The foundations to the property were found to generally comprise corbelled brickwork footings bearing directly on the soil sub-stratum but set at a number of different levels.

5.4. The proposed basement works comprise the deepening of the existing underground spaces by 1.315m. However, the extended basement will be founded 3.5m or so below the level of the front garden paving.

5.5. Subsequent to the initial audit, information was provided to show that a basement exists beneath one neighbouring property and an undercroft beneath the other (refer to Appendix 3).

5.6. Ground conditions at the site have been confirmed to comprise Made Ground to 3m bgl, overlying London Clay. A perched water table is anticipated in the Made ground.

5.7. The revised BIA has recommended that due to the potential for perched water in the Made Ground, waterproofing should be installed to the basement and that provision should be made for local dewatering during construction. This is accepted.

5.8. The revised BIA has confirmed that although the London Clay is the shallowest 'natural' stratum at the site, the stratum occurs at depth and there is no evidence of shrink/swell effects in local buildings. Also, there are no significant trees along the street frontage or in the back garden to the property. Nevertheless, a check will be made during basement excavation for any signs of desiccation.

5.9. The revised BIA has confirmed that following remedial works to drainage systems in Camden, Aldred Road is now not considered to be at risk of surface water flooding.

5.10. Basic structural calculations have been provided in the revised BIA for the RC basement walls and an error noted in the original calculations has been remedied (refer to Appendix 3).

5.11. No calculations and/or information on propping arrangements have been provided for the mass concrete underpins to demonstrate that stability under lateral earth pressure loads will be maintained. It is stated that the propping will be designed by the contractor. It is recommended that this detail is agreed with the Party Wall Surveyor.

5.12. A ground movement and building damage assessment has been provided which conforms that the category of building damage due to basement construction is anticipated to accord with Burland Category 1 (Very Slight). This is accepted provided there is good control of workmanhip and the affected buildings are in sound condition.

5.13. The revised BIA has confirmed that information on construction sequencing, ground movement monitoring, action trigger levels, contingency provisions etc. will be provided in compliance with the requirements of the Party Wall Act.

5.14. An indicative programme has been submitted in the revised BIA.

Appendix 1: Residents' Consultation Comments

None

Appendix 2: Audit Query Tracker

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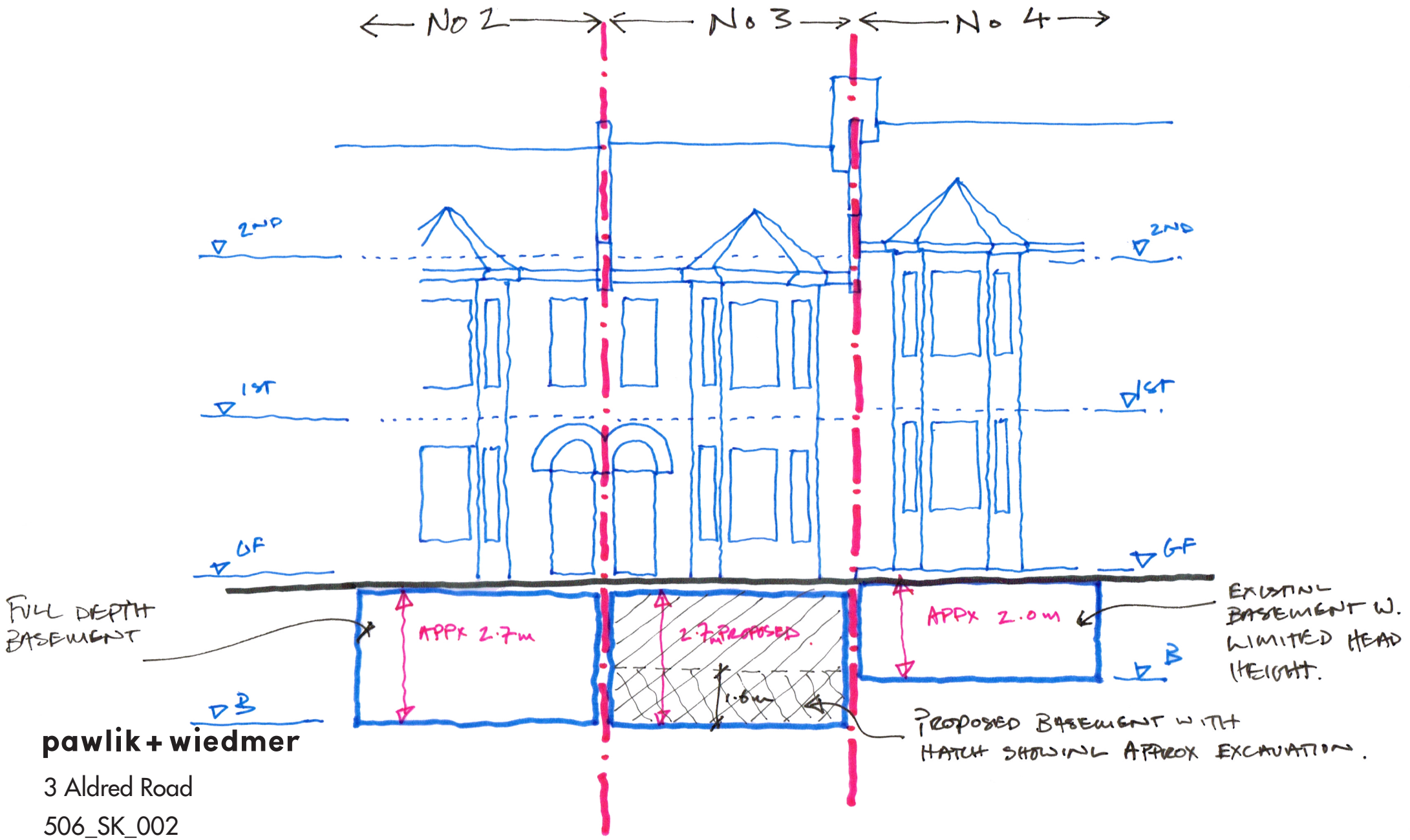
consulting engineers

Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	Hydrology	The standpipe in front of the property is reported to be defective. Groundwater levels remain to be confirmed.	Closed. Additional monitoring has confirmed groundwater levels to be low. However, as noted in the revised BIA, groundwater levels may rise after a rainfall event and waterproofing should be installed to the basement and provision made during basement excavation for pumping.	19/01/16
2	Hydrology	The history of flooding in the local area is to be researched and the situation clarified.	Closed. The revised BIA has confirmed that following remedial works to drainage systems in Camden, Aldred Road is not now considered to be at risk of surface flooding.	19/01/16
3	Stability	Evidence or otherwise of history of shrink-swell subsidence in the local area to be substantiated.	Closed. It has been confirmed in the revised BIA that there is no evidence of seasonal shrink-swell subsidence in the local area. It is also confirmed that the ground at the site will be checked during basement excavation for any signs of desiccation.	19/01/16
4	Stability	Consideration to be given to the proximity of the works to Aldred Road and the temporary support requirements for the road and associated services.	Closed. Additional details have been provided in the revised BIA.	19/01/16
5	Stability	Calculations for retaining wall/underpinning design to be provided.	Open. Preliminary calculations have been provided for the permanent lightwell cantilever walls. However, there are errors in these which should be corrected – see Section 4. Calculations and/or information on propping arrangements should	29/02/16

			also be provided to demonstrate the stability of the underpinning walls when subject to lateral earth pressures.	
6	Stability	Ground movement predictions to assess the likely structural impact of basement construction on adjacent properties and the likely category of damage to be undertaken.	Open. A quantitative GMA and building damage assessment to CIRIA C580 is required to be undertaken to assess the likely building damage category for the adjacent properties. This is required before the audit can be closed out.	29/02/16
7	Stability	A programme of works is to be provided.	Closed. An indicative programme has been submitted in the revised BIA.	19/01/16
8	Stability	The designer's requirements regarding construction sequencing, propping, ground movement monitoring, contingency provisions etc. are to be fully specified in the contract documents for the works so that the contractor is made fully aware of the levels of compliance required.	Closed. The revised BIA has confirmed that the information listed will be provided in compliance with the requirements of the Party Wall Act.	19/01/16
9	Stability	No information has been supplied on the presence or otherwise of adjacent basements. This information should be provided.	Open.	29/02/16

Appendix 3: Supplementary Supporting Documents



pawlik+wiedmer

3 Aldred Road

506_SK_002

Sketch showing presence and estimated depth of adjacent basements to No 3 Aldred Road

pawlik + wiedmer

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Regeneration and Planning
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10th February 2016

501 // 3 Aldred Road – BIA Audit Queries

Dear Kate,

We are writing in response to the Campbell Reith - Basement Impact Assessment Audit - Revision D2. They have asked for additional clarifications and information. We have spoken to the author of the Audit to establish what is required. We hope that the responses below in addition to the additional information provided below will do so.

Query 5

Retaining Wall – Section 4.23, 5.11

Price & Myers have corrected the small numerical error in the retaining wall calculation. The correction is shown in red in the revised P&M document attached which also states that the design is still 'OK' i.e. safe. (*24077_Calc RW1 RevA_Retaining Wall_20160201)*

Propping – Section 4.23, 5.12

The Construction sequence and indicative propping arrangement is already shown in P&M Sk10-11 provided as part of the BIA Screening report (July 2015) with additional information regarding the front area in P&M SK 12 provided in response to CR Audit revision D1 (December 2015) audit items 4 and 8 are noted and agreed as closed out.

The propping arrangements are hard to define at planning stage as a contractor has yet to be appointed and may have a preferred method of carrying out the work. The design team would expect to indicate where temporary propping is required – as we have done – but we would not expect to have to do further design of the propping at this early stage. The works design will ultimately be undertaken by the contractor. Their design will then be reviewed by the engineer prior to works commencing on site to ensure it is adequate.

Query 6

P&M have carried out a Quantative GMA and Building Damage Assessment to CIRIA C580 as requested by CR Audit Revision D2 (see attached). It is noted that this is an inherently conservative calculation and assumes a full depth of soil (i.e. no existing undercrofts) and excavation depth to formation level. Even with this worst case the outcome for this site is damage category 1 – very slight. The actual conditions (see query 9) will mean the actual movements should be lower than these estimates. (*24077_Ground movements and building damage assessment)*

Query 9

Following enquiries with adjacent owners we note the presence of basements or undercrofts to both neighboring properties as illustrated in the attached sketch (501_SK_002). We understand No 4 has the same undercroft as No3, a shallow basement with head height of approximately 2m. No 2 has a full depth basement under the full footprint of the building with a front light well onto the street. The presence of these basements should reduce CR's concern regarding deepening the existing foundations affecting how the building behaves and will reduce the differential ground movement and strains in item 6 above. (*501_SK_002_Adjoining Basements)*

We trust that these responses answer the Auditors outstanding queries 5, 6 & 9. However if there are any further queries please do not hesitate to contact us.

Yours Faithfully

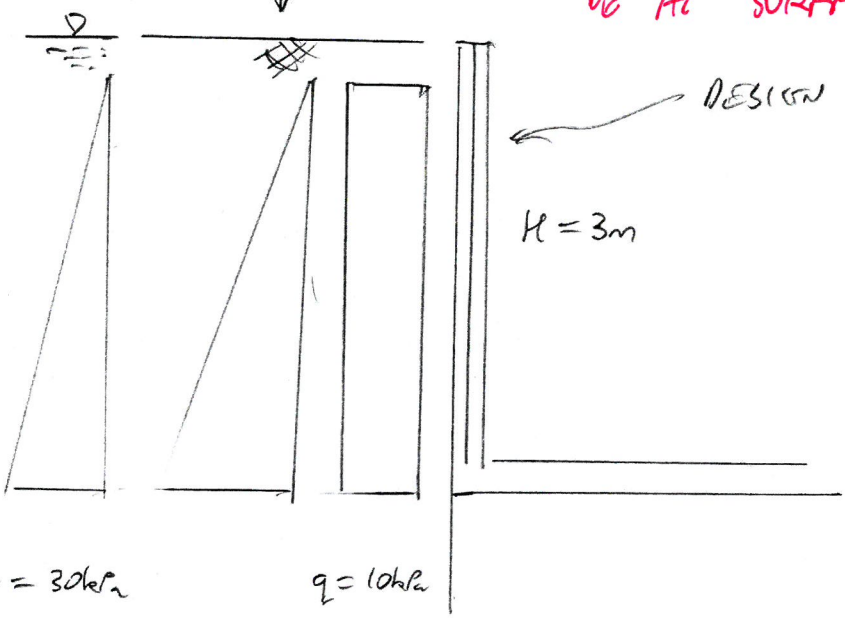
Nicholas Pawlik

Enc:

- *24077_Calc RW1 RevA_Retaining Wall_20160201*
- *24077_Ground movements and building damage assessment*
- *501_SK_002_Adjoining Basements*

RETAINING WALL

CONSERVATIVE ESTIMATE. WATER NOT REQUIRED TO BE AT SURFACE LEVEL.



$\sigma_v = 3 \times 18$
$= 54 kPa.$

Moment on wall $= K_o \frac{\sigma_v}{2} \cdot H \cdot \frac{H}{3} + \frac{wH}{2} \cdot \frac{H}{3} + qH \cdot \frac{H}{2} K_o$

$= 0.66 \times \frac{54}{2} \times \frac{9}{3} + \frac{30}{2} \times \frac{9}{6} + 10 \times \frac{9}{2} \times 0.66$

$= 98$ ~~128~~ kNm/m SLS.

$1.4 \times 98 = 137$ ~~179~~ kNm/m ULS. Still << M_{ult} ⇒ OK.

$M_{ult} = \frac{0.156 \times 30 \times 1000 \times 225^2}{10^6} = 240$ kNm/m

⇒ 300 RC RETAINING WALL OK AS TEMPORARY CANTILEVER. PROPPED AT HEAD IN PERMANENT CASE.

PRICE&MYERS
Consulting Engineers

Job No 24077 Page 0-1 Ver

Date 8/2/16 Eng IK 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.

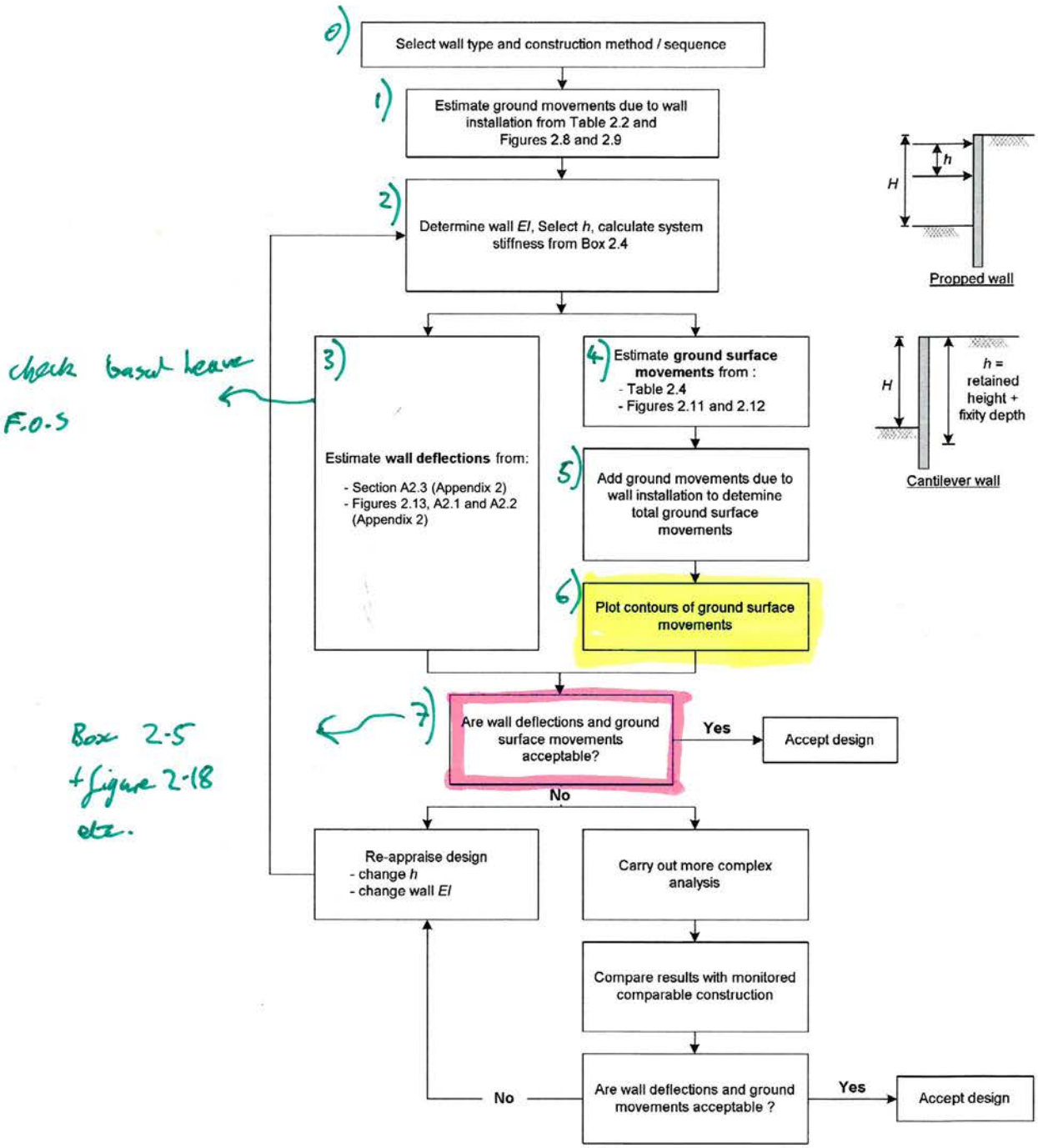


Figure 2.14 *Procedure for prediction of wall deflections and ground surface movements*

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), Appen
base stability.

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

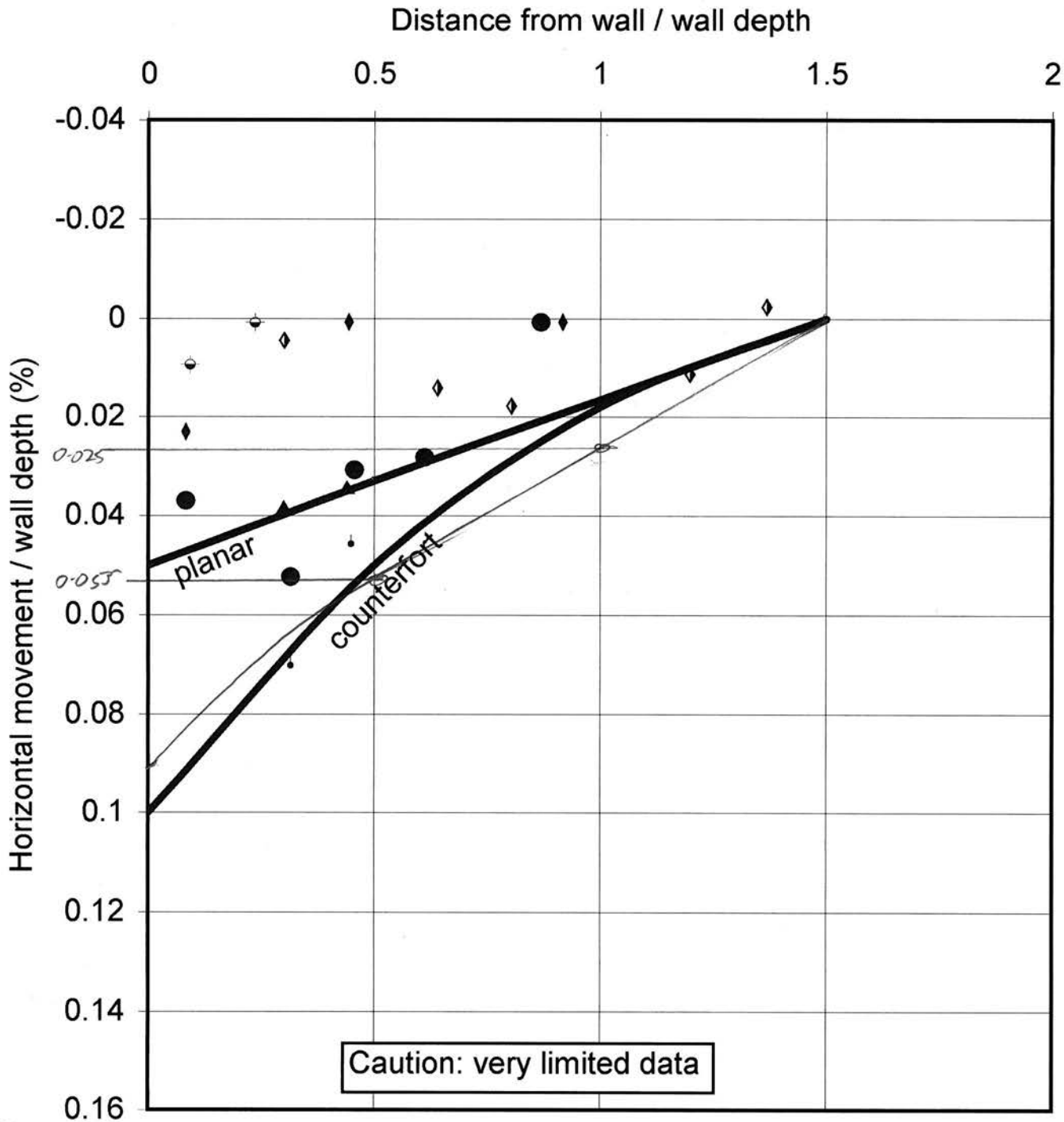
$\frac{\delta hi}{D} = 0.04 + 0.05 = 0.09\%$ at OD spacing

for 1.5D from excavation.

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

for 2D from excavation.

Spacing	$\delta hi/D$ %	$\delta vi/D$ %
OD	0.09	0.09
0.50	0.055	0.045
1.00	0.025	0.02
1.5D	0	0.008
2.0D	0	0



Key:

Site | Wall Type

P: Planar diaphragm wall
CF: Counterfort diaphragm wall

See Appendix 2 for details of case histories

- ● A406/A10 Jn | CF
- ▲ Aldershot Road | CF
- ♦ East of Falloden Way (2) | P
- ◊ New Palace Yard | P
- ⌖ Reading | P
- • Walthamstow (2) | CF

(Combined bank sheet + RC wall similar to pile wall with planar diaphragm)

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

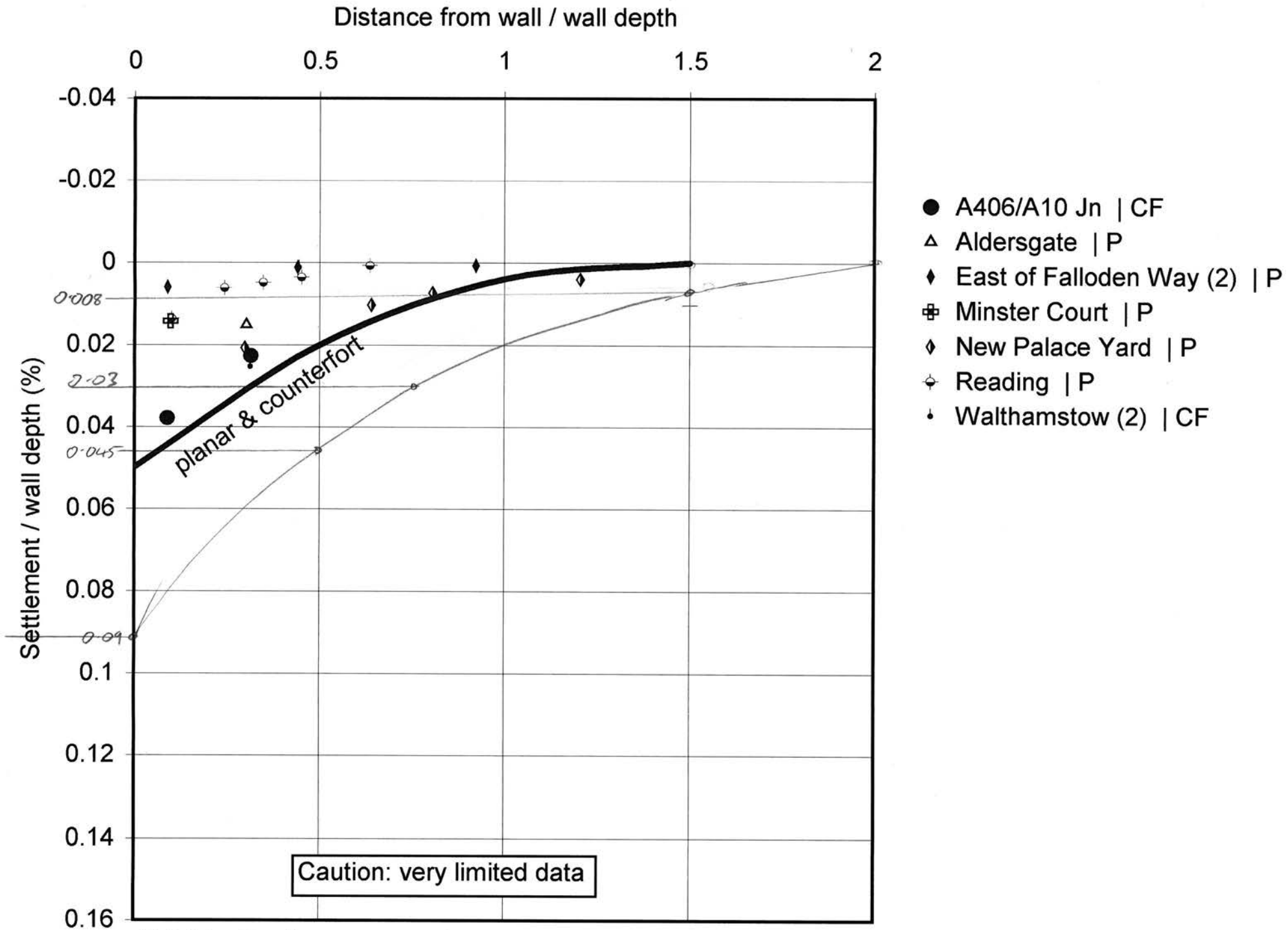
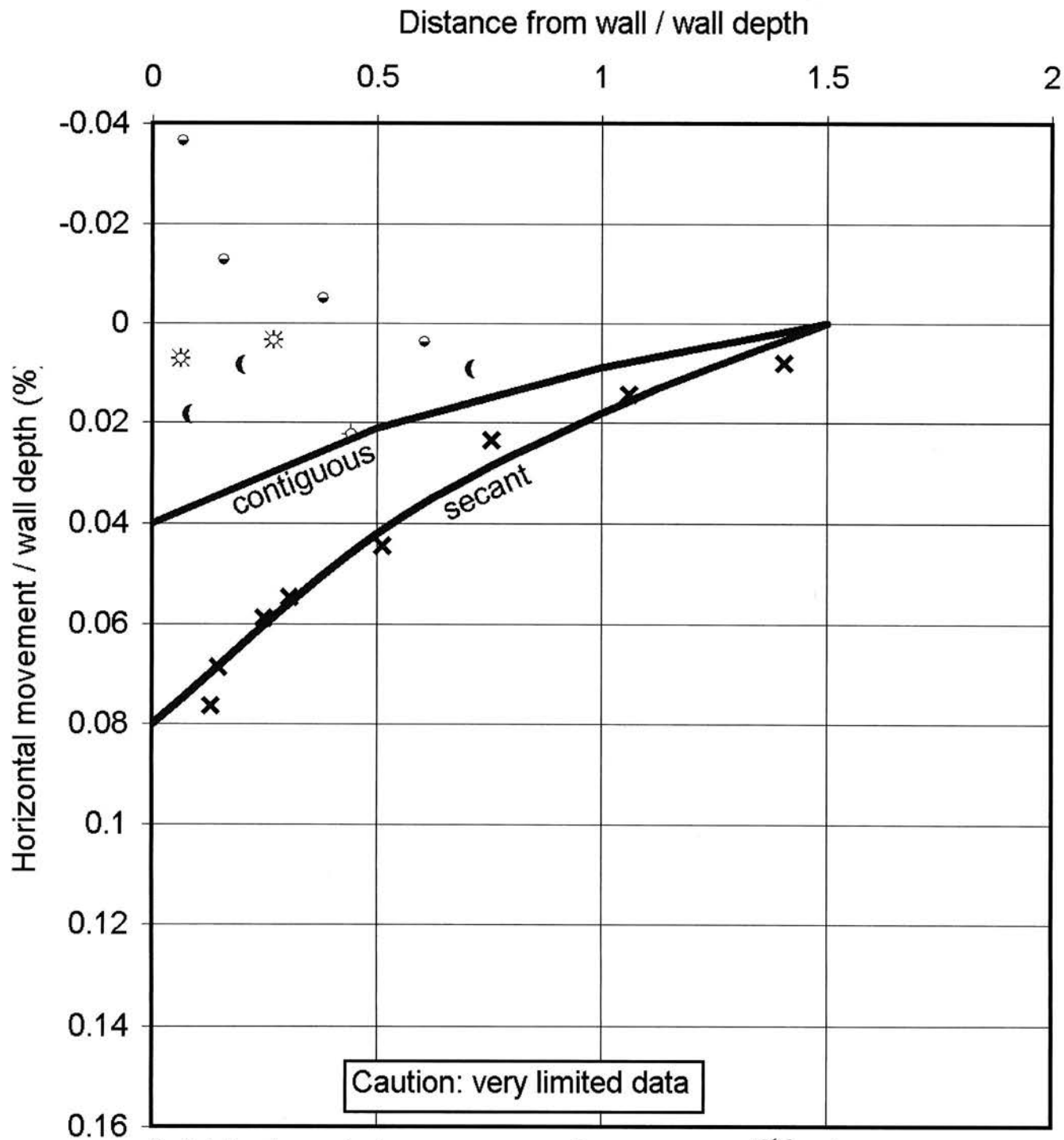


Fig 2-9 **(b)** Vertical movements



Key:

Site | Wall Type

CPW: Contiguous bored pile wall
SPW: Secant bored pile wall

See Appendix 2 for details of case histories

- × Bell Common | SPW
- ☼ East of Falloden Way (1) | CPW
- ● Hackney Wick | SPW
- ☼ Rayleigh Weir | CPW
- ☾ Walthamstow (1) | CPW

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

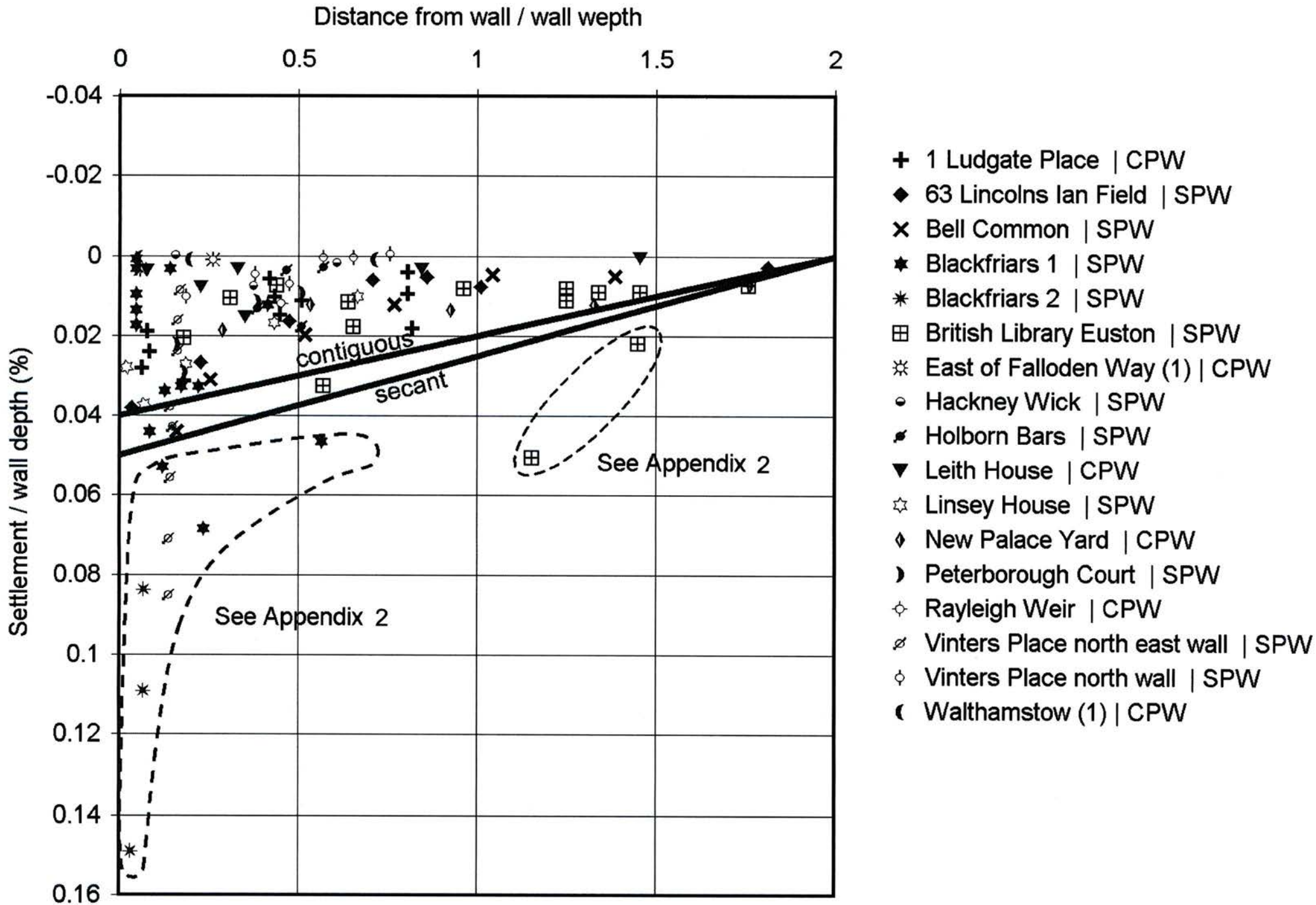
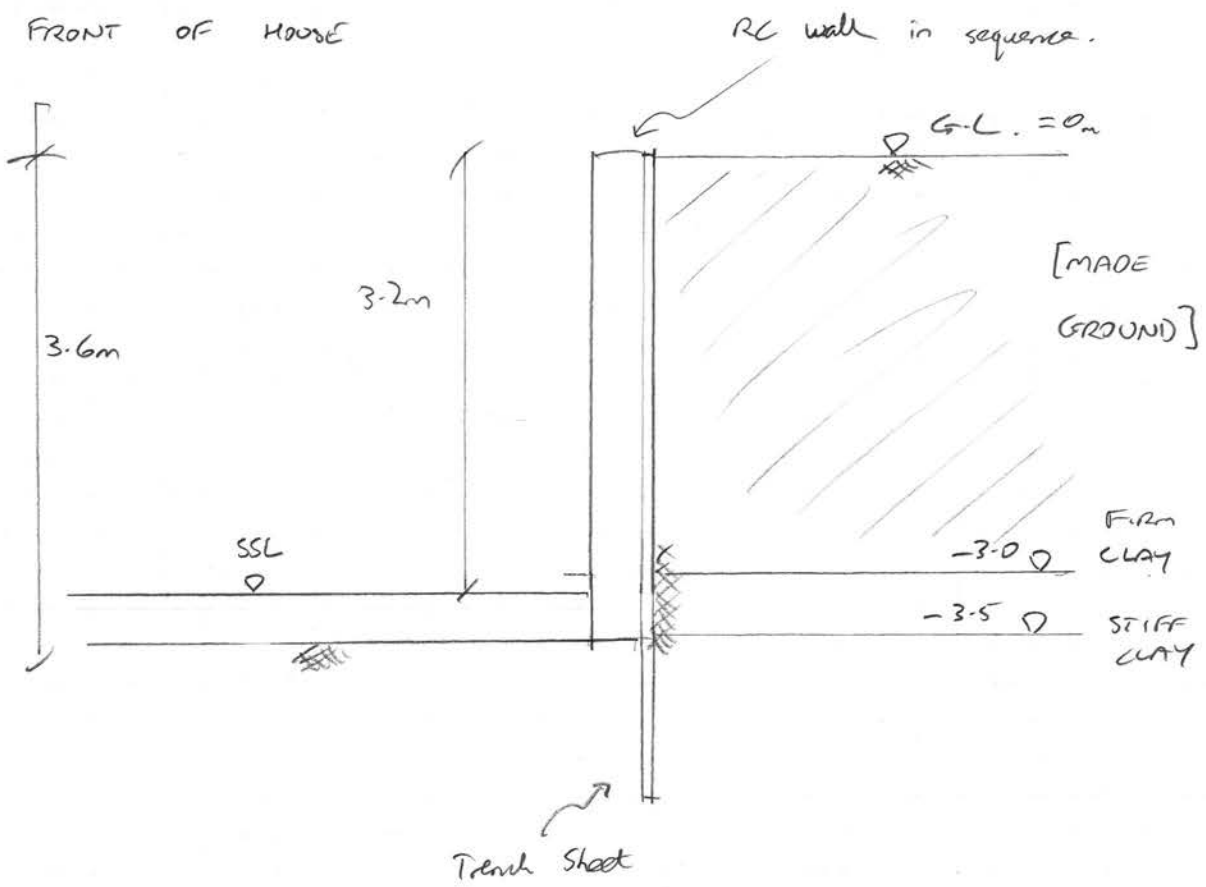
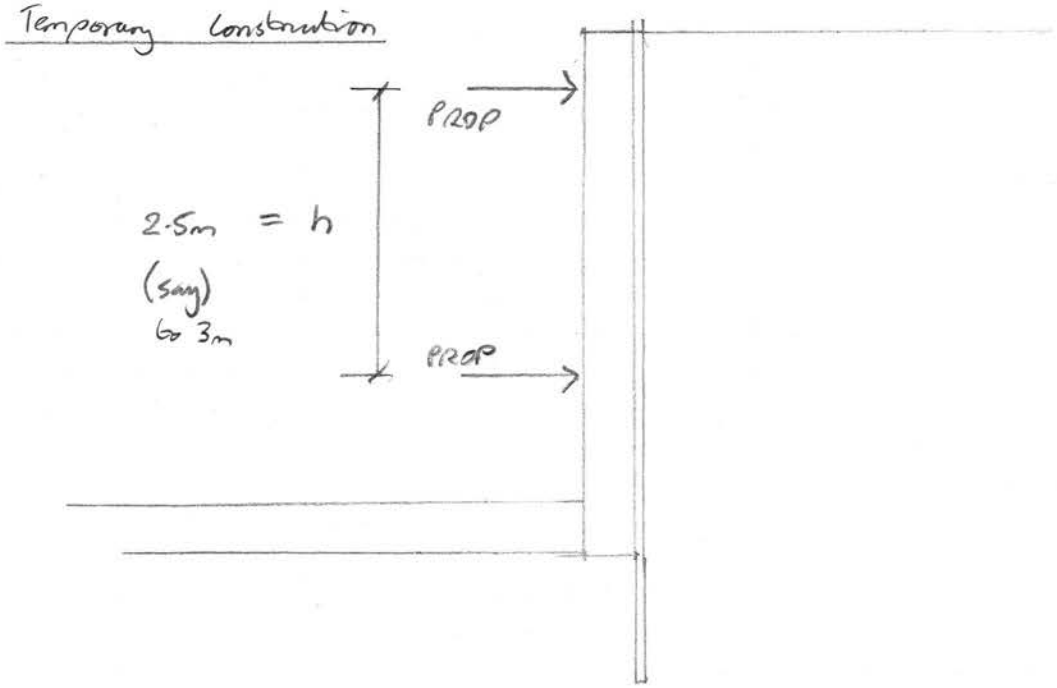


Fig 2.8 **(b) Vertical movements** in stiff clay

2)


FRONT OF HOUSE
RC wall in sequence.
G.L. = 0m
3.6m
3.2m
[MADE GROUND]
SSL
-3.0
FIRM CLAY
-3.5
STIFF CLAY
Trench Sheet


Temporary Construction
PROP
2.5m = h
(say)
Go 3m
PROP

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Job 3 ALDRED ROAD

	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 $h = 2m$

$\rho_s = 0.852$ N/m per m

$\rho_s = 37$ N/m per m

if γ_w = water only ($10 kN/m^3$)

then

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

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

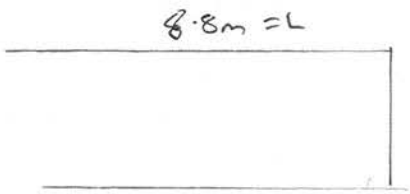
$\rho_s = 67$ N/m per m

BASE HEAVE STABILITY

(TOMLINSON 9.7)

$D_L = \frac{N_c s}{\gamma}$ $\quad s = c_u = \min 4.5N = 86\,kPa.$

$N_c = 6.2$



$D = 1.6m$

Shape 1 $\quad \frac{B}{L} = 0.57 \quad \frac{D}{B} = 0.32$

shape 2

$D = 3.6m$

$\frac{B}{L} = 0.4 \quad \frac{D}{B} = 1.8$

$N_c = 7.5$

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

$F = \frac{N_c s}{\gamma D + P} = \frac{6.2 \times 86}{18 \times 3.5 + 10} = 7.3 > 3$ ✓ 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 $D = 3.0m$

$= 12mm$ 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

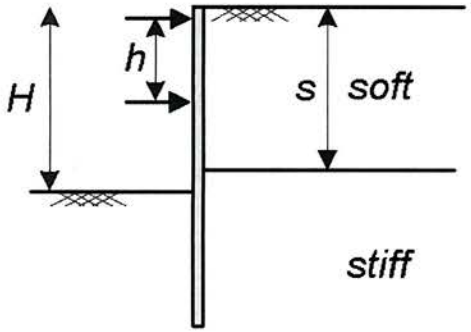
$\frac{\delta_{h\,max}}{D}$ approaches 0.1% for $\rho = 30$ to 70

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

3) SECTION A2-3

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

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



s > 0.6H
stiff soil at
dig level

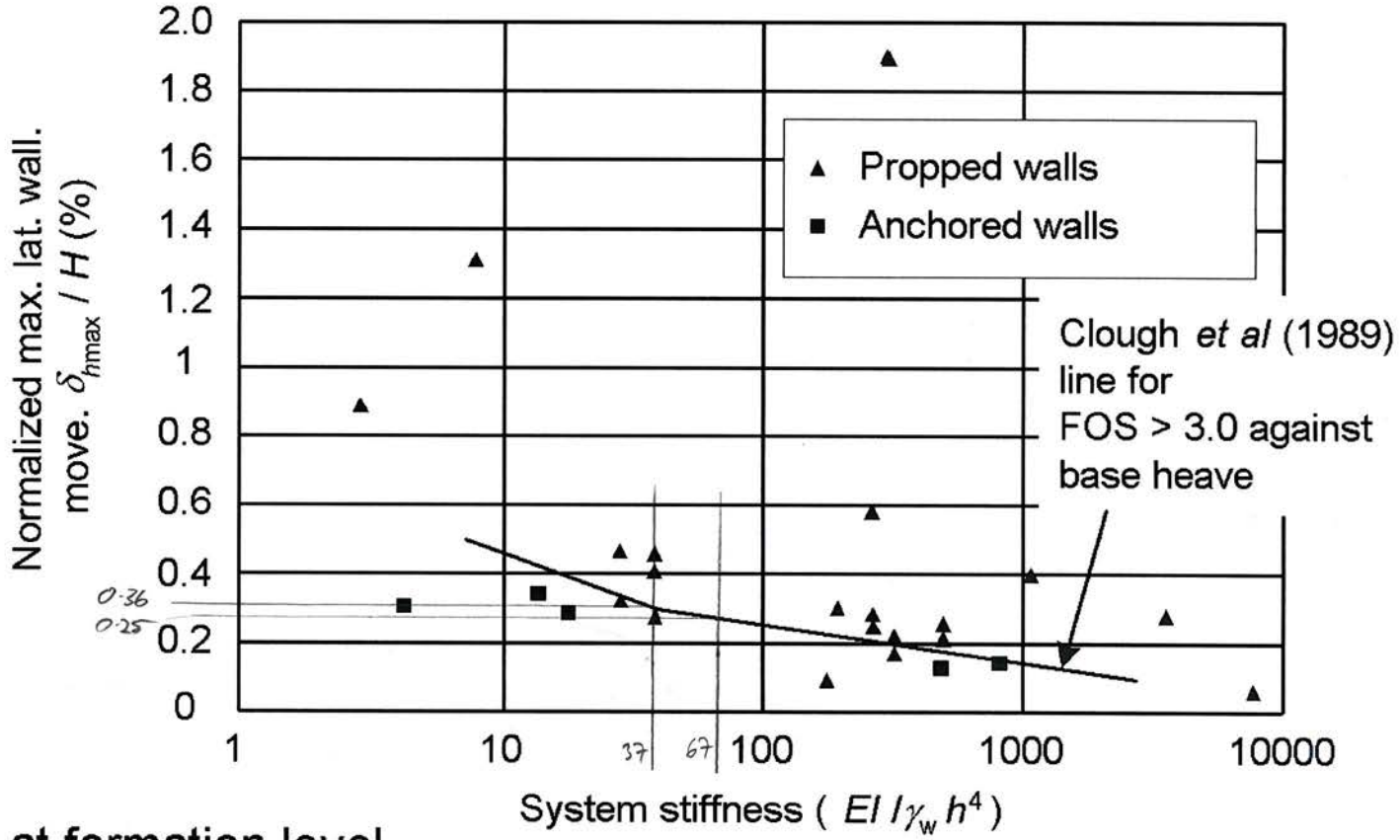


Figure A2.2

(b) Walls with s>0.6H - stiff soil at formation level

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Job No 24077 Page 3-2 Rev
Date 5/2/16 Eng IK Chd
Job 3 ALORED ROAD

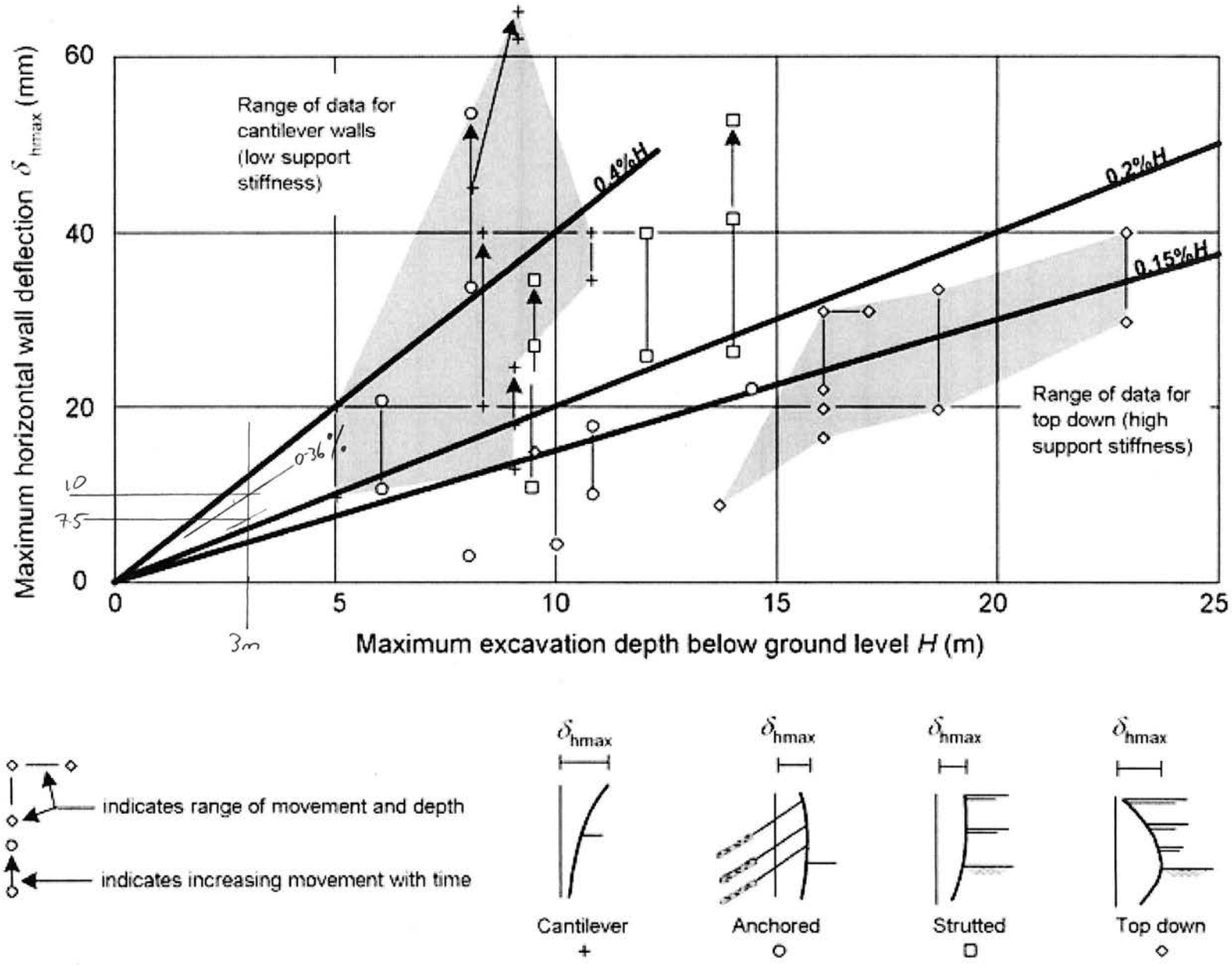

Figure A2.1 *Observed maximum lateral wall deflections for excavations in London Clay (after St John* et al*, 1992)*

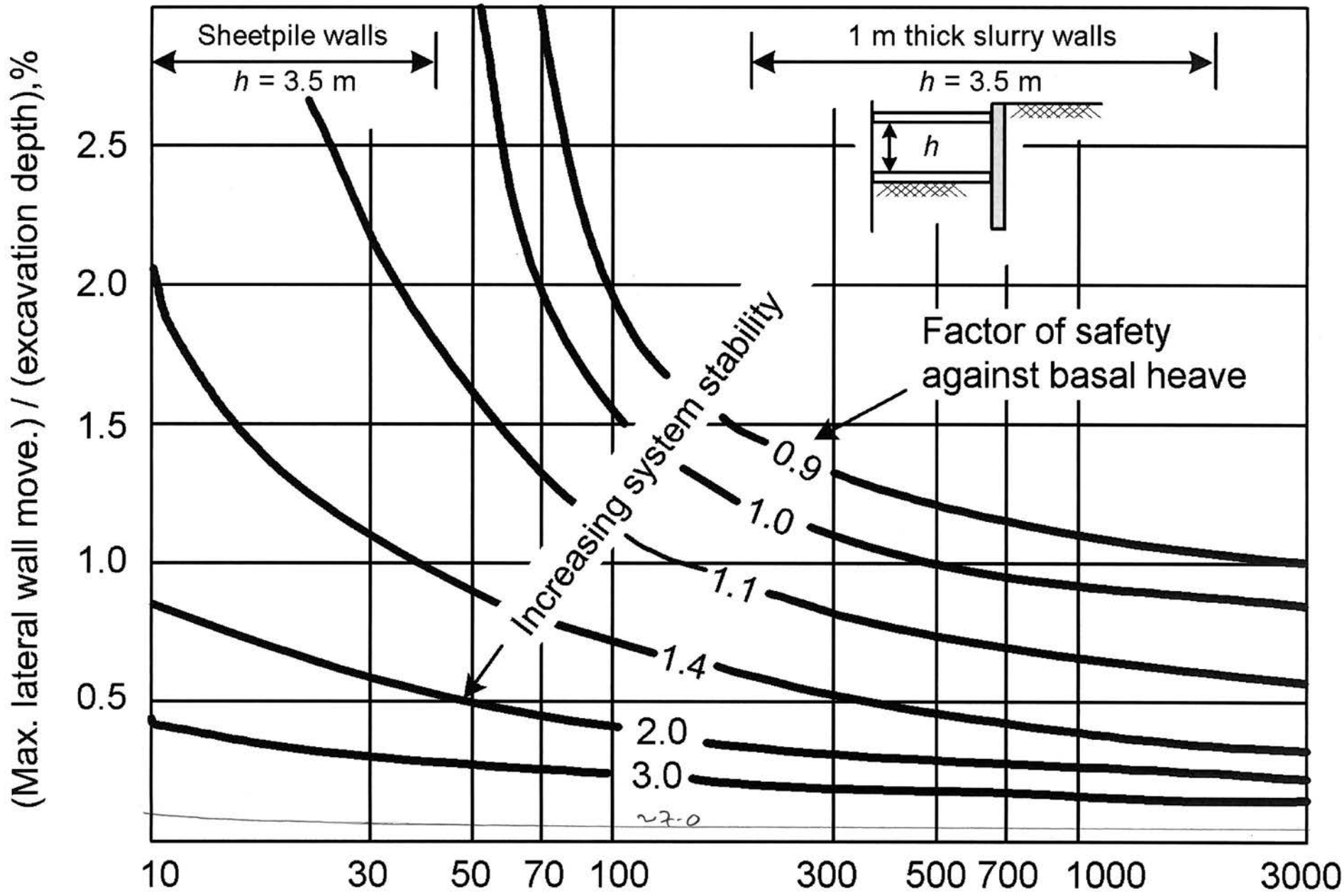

Figure 2.13 *Maximum lateral wall movement versus system stiffness (after Clough* et al, *1989)*

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.

⇒ 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 $\frac{\delta v}{D} = 0.024\%$

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

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

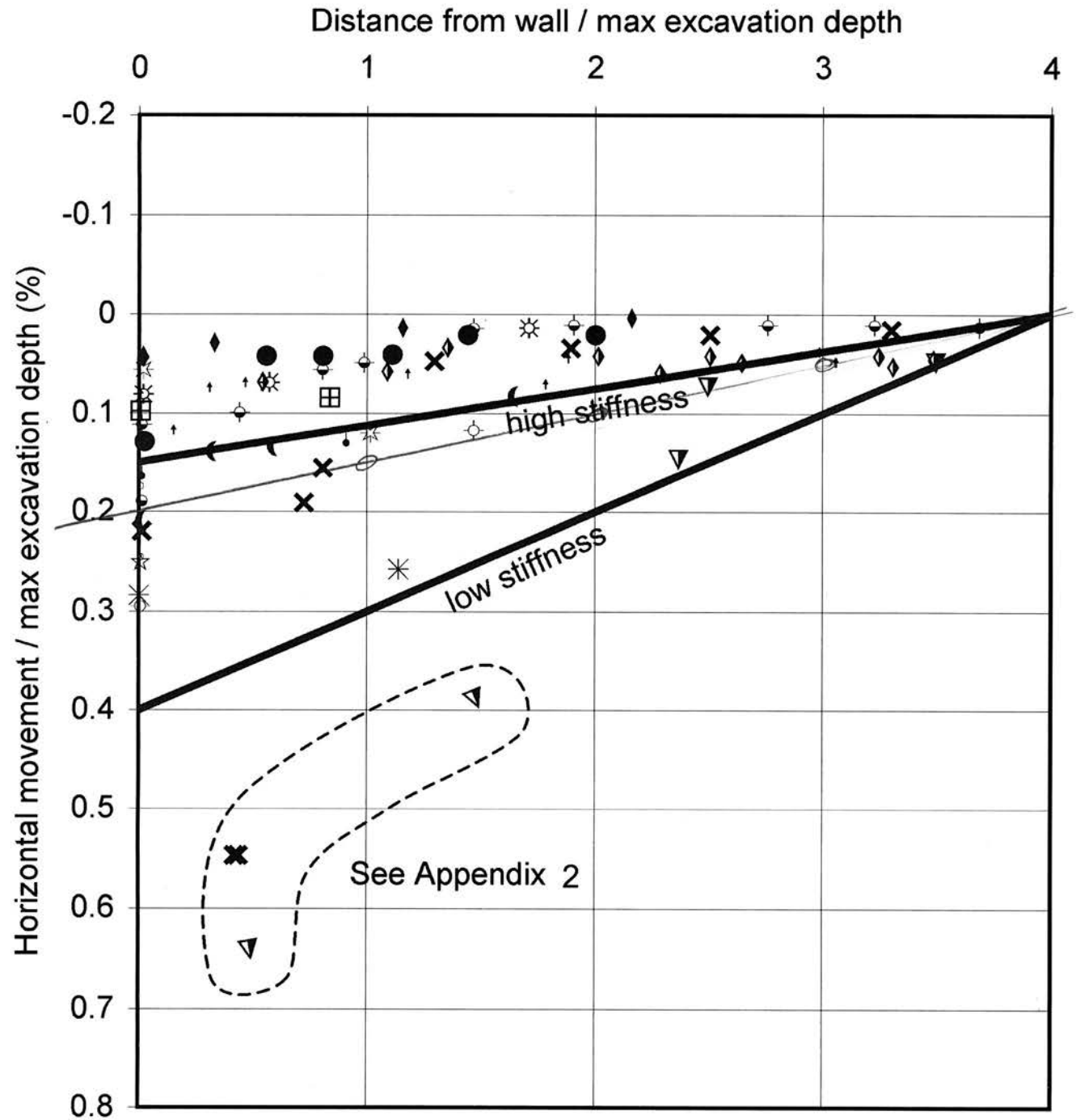

Fig 2.11 **(a)** Horizontal movements in stiff clay

Key:

Site | Wall Type

CPW: Contiguous bored pile wall
SPW: Secant bored pile wall
DW: Diaphragm wall
KP: King post wall

See Appendix 2 for details of case histories

- ● A406/A10 Jn | DW
- × Bell Common | SPW
- ✳ Britanic House | DW
- ⊞ British Library Euston | SPW
- ☼ East of Falloden Way (1) | CPW
- ♦ East of Falloden Way (2) | DW
- ◒ Hackney Wick | SPW
- ☆ Limehouse Link | DW
- ✲ Lion Yard | DW
- ▽ Neasden | DW
- ♦ New Palace Yard | DW
- ☼ Rayleigh Weir | CPW
- ✦ Reading | DW
- ◖ Walthamstow (1) | CPW
- • Walthamstow (2) | DW
- ◦ Waterloo Int'l Terminal | DW
- † YMCA | DW

F12

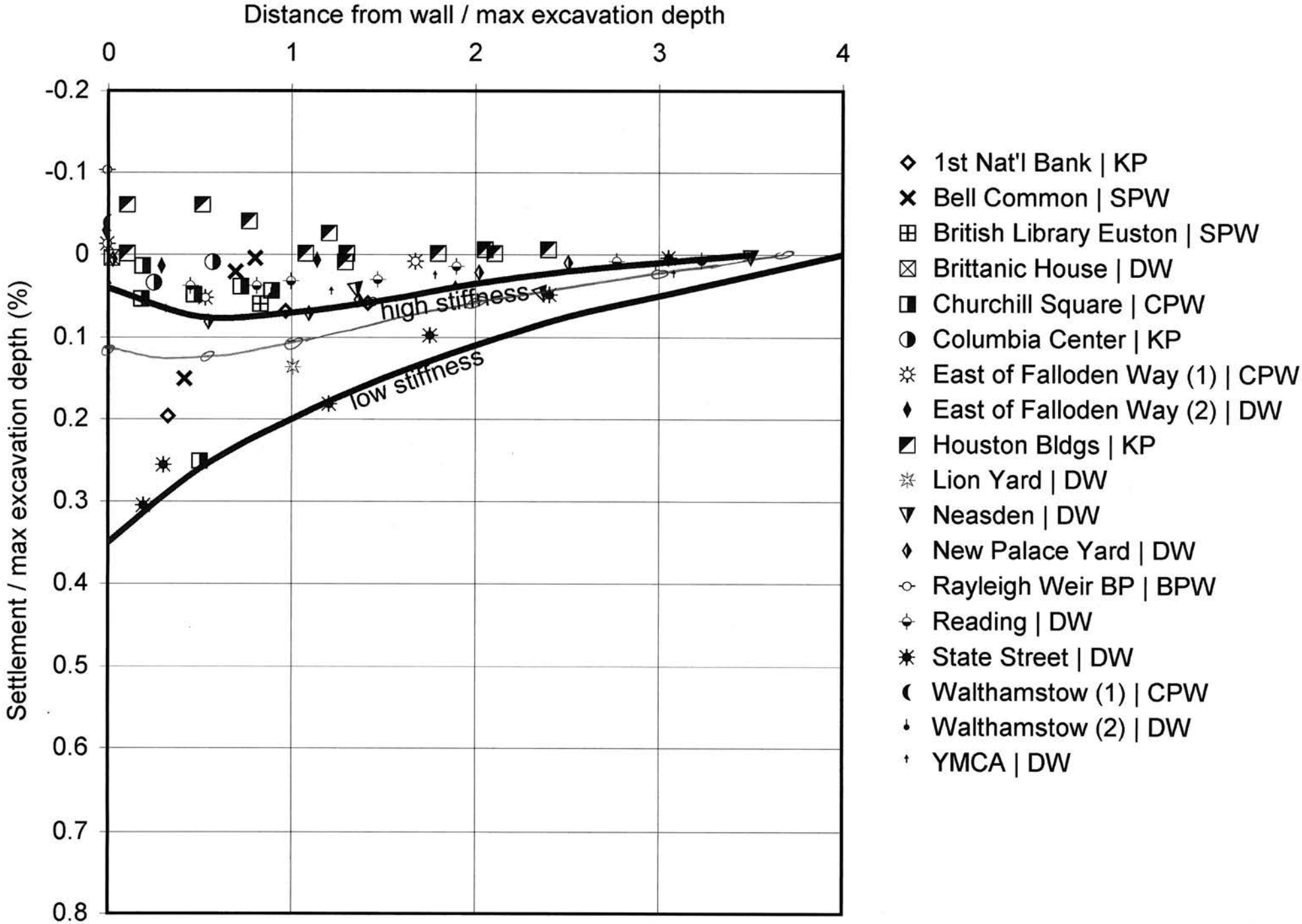

Fig 2-11 **(b)** Vertical movements in stiff clay.

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Job 3 ALDRED ROAD

5) TOTAL GROUND MOVEMENT:

Spacing	δ_v total	δ_h total
0D	0.2%	0.29%
0.50	0.16%	0.23%
1.00	0.125%	0.17%
1.50	0.081%	0.125%
2.00	0.06%	0.10%
3.00	0.024%	0.05%
3.70	0	0.025%
4.00	0	0

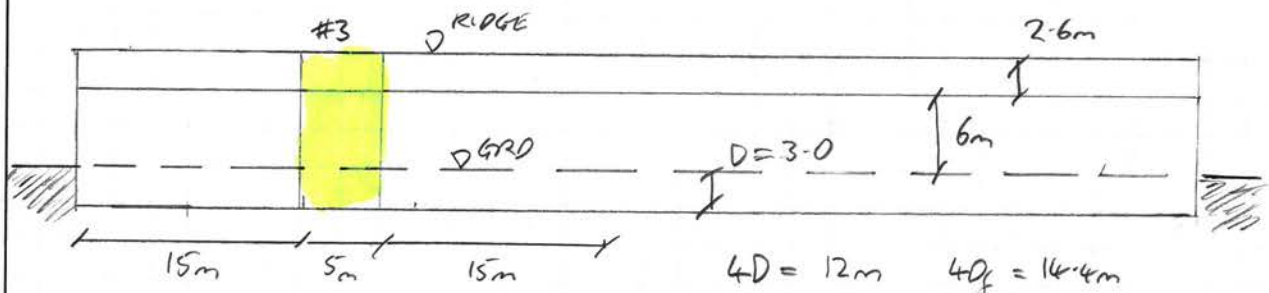
7) DAMAGE CATEGORY ASSESSMENT

i) STRUCTURE L AND H:

MID TERRACE OF 14 houses (one double width)

house width ≃ 5m

⇒ total length = 75m



4D = 12m 4D = 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 } beneath
10·2m at ridge to existing LG. } 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.

$\Rightarrow \Delta = \delta_{v\,max} = 0.2\% \times D = 6mm$ for $D = 3m$

$7.2mm$ for $D_f = 3.6m$

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

$\frac{L_1}{H} = \frac{35}{6} = 5.83$ (front façade)

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

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

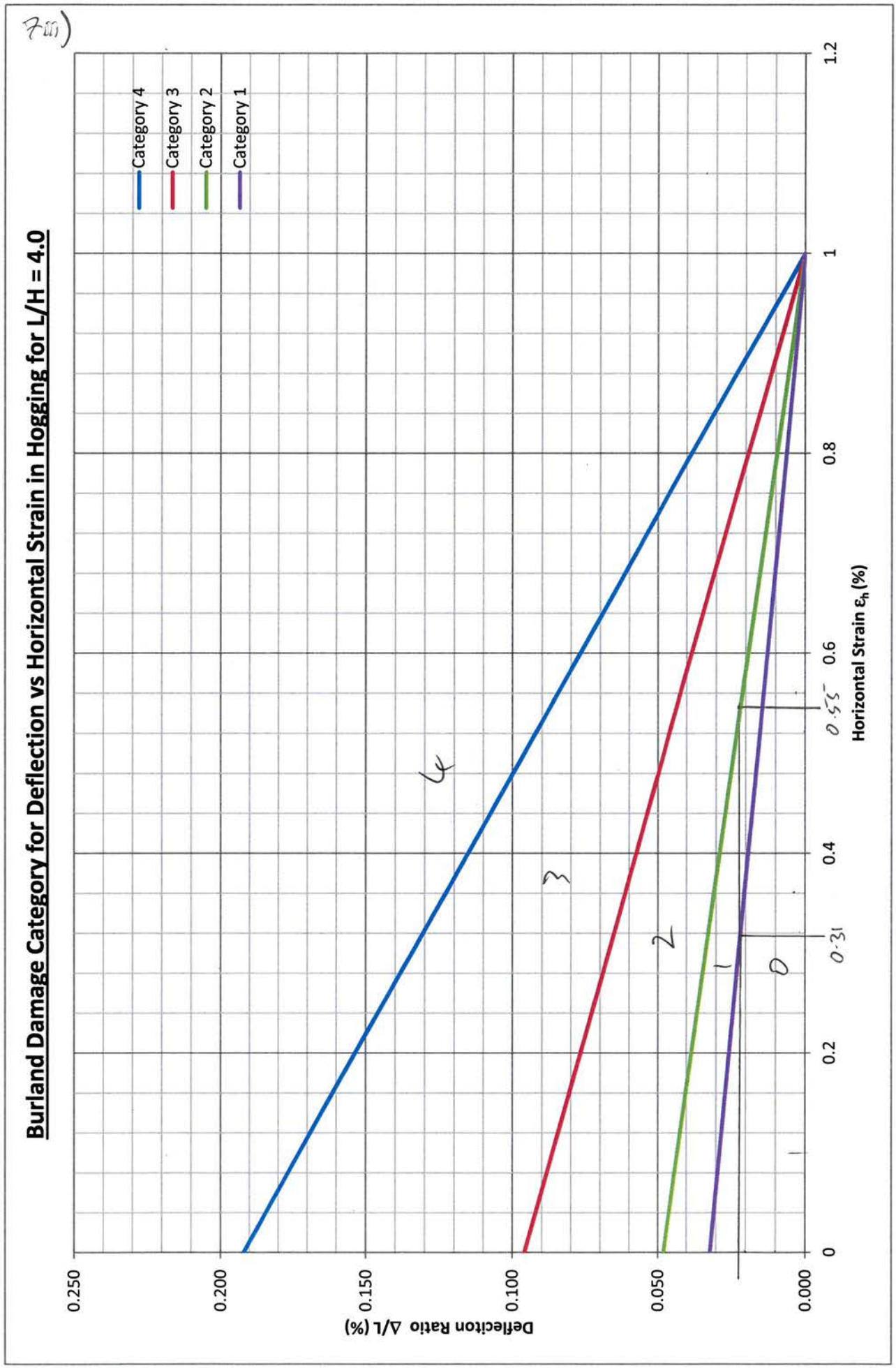
$\frac{L_3}{H} = \frac{15.4}{10.2} = 1.5$ (ridge to existing LG)

$(0.2 - 0.05)\% D$.

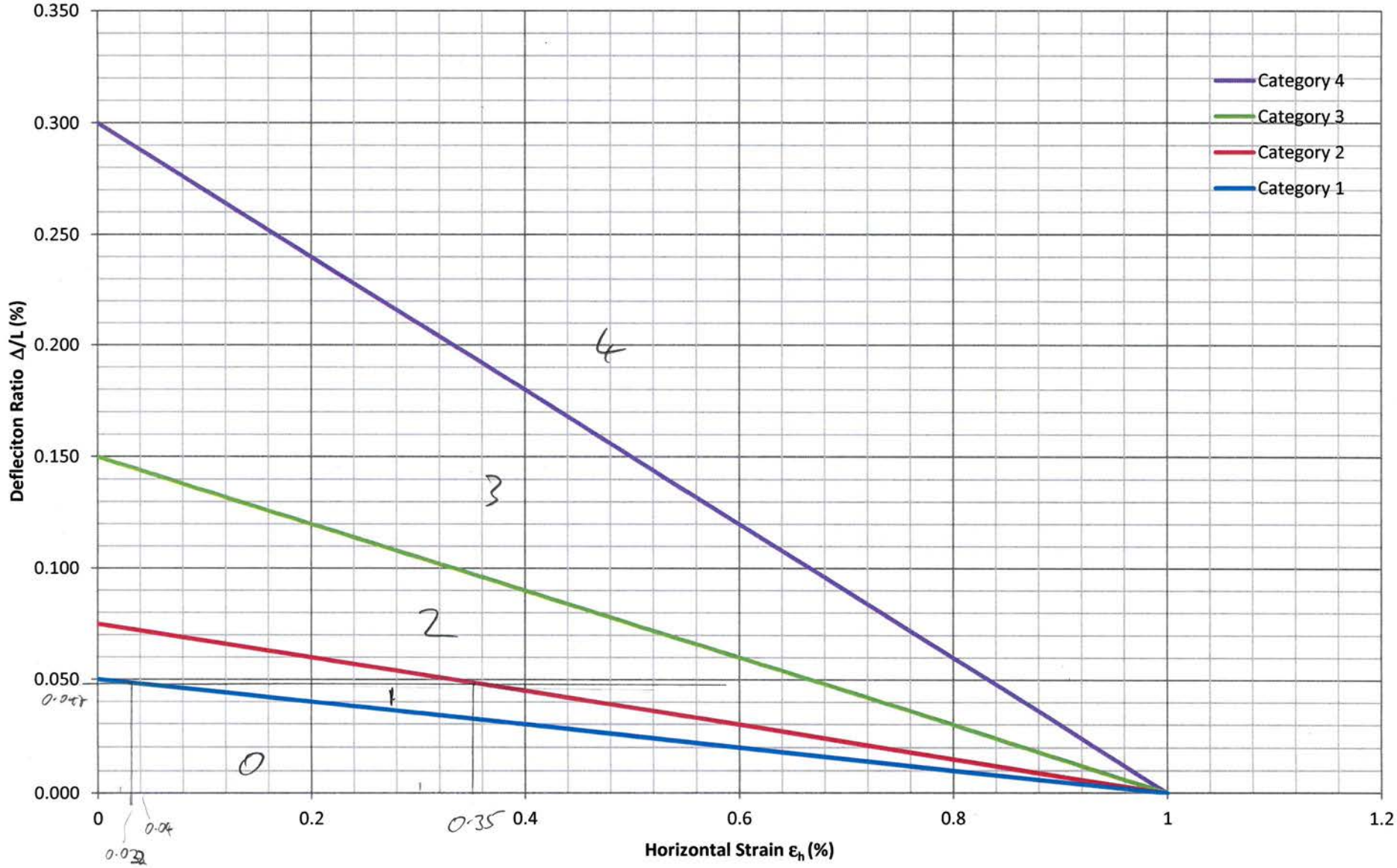
$\frac{\Delta}{L} = \frac{5.4}{8000} < 0.068\%$ $8 = 2.2D$

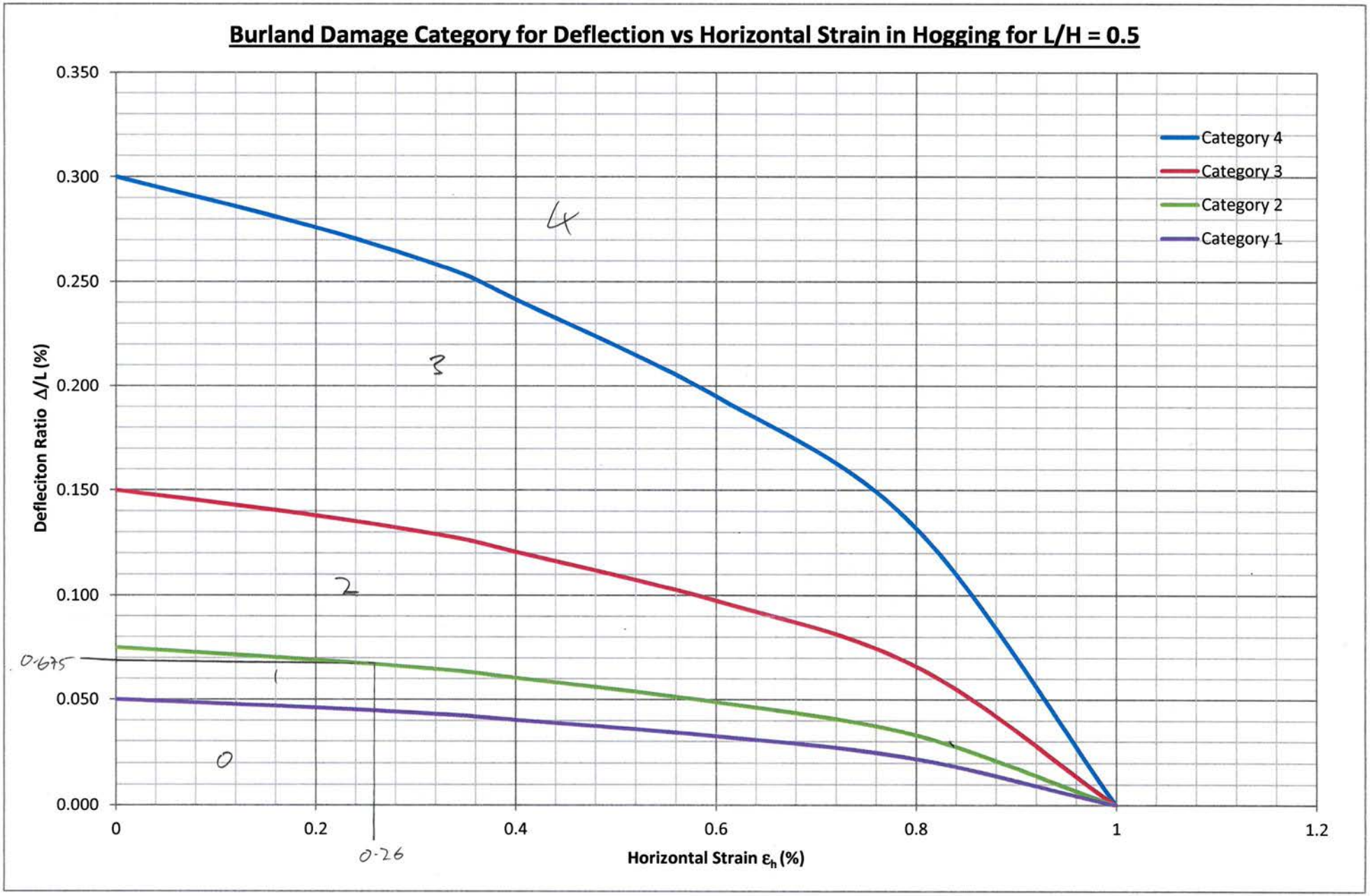
$\frac{L_2}{H} = \frac{8}{10.2} = 0.78$ (ridge to existing LG).

7(iii)


Burland Damage Category for Deflection vs Horizontal Strain in Hogging for L/H = 4.0
Category 4
Category 3
Category 2
Category 1
Deflection Ratio Δ/L (%)
0.250
0.200
0.150
0.100
0.050
0.000
Horizontal Strain ε_h (%)
0
0.2
0.4
0.6
0.8
1
1.2
0.55
0.31
4
3
2
1
0
1

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




Burland Damage Category for Deflection vs Horizontal Strain in Hogging for L/H = 0.5
Deflection Ratio Δ/L (%)
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0
0.2
0.4
0.6
0.8
1
1.2
Horizontal Strain εh (%)
Category 4
Category 3
Category 2
Category 1
4
3
2
1
0
0.675
0.26

7iv) -v)

FROM INTERACTION PLOTS (SIMILAR TO Fig 2-18c in CS80)

For $\frac{L}{H} = 5.8$ (SIMILAR CURVE TO $\frac{L}{H} = 4$)

$\varepsilon_h = 0.31\%$ Limit for category 0 with $\frac{\Delta}{L} = 0.021\%$

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

Along terrace

For $\frac{L}{H} = 1.5$

$\varepsilon_h = 0.032\%$ Limit for category 0 with $\frac{\Delta}{L} = 0.047\%$

0.35% Limit for category 1

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

Front - Rear. inc Extension

For $\frac{L}{H} = 0.78$ use $\frac{L}{H} = 0.5$

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

$\varepsilon_h = \frac{\delta_h}{L} = (0.29 - 0.09) = 0.2\%$ ✓ OK $\Rightarrow$ category 1

Front - rear of main house

7vi)

Conclusion

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

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