Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, CL:AIRE, March 2025

A Review

Review: Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, CL:AIRE, March 2025[1]

Introduction

The new CL:AIRE guidance builds upon the foundations laid by the Environment Agency's 2001 guidance document (NC/99/73) and includes newer piling techniques, recent research and additional aspects including water born turbidity and water quality at abstraction wells.

This review primarily focuses on the updated guidance in respect of ground gas issues.

The CL:AIRE document provides an excellent overview of the different piling techniques including bearing piles, sheet piles and penetrative ground improvement techniques. It regularly uses relevant and informative illustrations and photographs. In describing each technique, the document identifies the various adverse, potentially contaminating effects with reference to the source-pathway-receptor (S-P-R) contaminant linkages.

Ground Gas Scenarios

Of the seven possible pollution scenarios that are identified and described, two consider ground gas issues:

- **Scenario 5** considers the creation of preferential pathways, including through a low permeability layer, to allow upward migration of landfill gas, soil gas, mine gas or contaminant vapours (e.g. Volatile Organic Compounds (VOCs)) to the surface.
- **Scenario 6** considers causing off site migration of ground gas or increased vertical emissions as a result of vibration or other effects from the pile installation process.

For each of these scenarios, the likely hazards associated with each generic method of piling and ground improvement are described. Problems and uncertainties are noted

[1] https://claire.co.uk/home/news/2083-piling-and-penetrative-ground-improvement-methods-on-land-affected-by-contamination-guidance-on-pollution-prevention

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and the effects of variations of piling methods within the generic classes are considered.

As referenced in other contamination guidance documents e.g. BS 8576, the document stresses the importance of using a robust, scaled diagrammatic conceptual site model.

Advice is also given on when groundwater and ground gas monitoring may be required during and/or after construction.

Comments

Within the background **Section 2**, the legislative and regulatory controls, legal issues and waste management are discussed.

It would have been nice to see reference made to the duties and responsibilities associated with the 'Golden Thread'. This concept was introduced in Dame Judith Hackitt's report 'Building a Safer Future', following the Grenfell Tower tragedy, and gained legal status through the Building Safety Act 2022. This act mandates the creation and maintenance of a 'Golden Thread' of safety information. This duty is placed on the development client, their principal designers and contractors during the design and construction phases of a project. Importantly, the 'Golden Thread' and the Act covers contamination issues that affect the health and safety of building users, including the ground gas risk assessment and foundation design stages.

Positively, the risk from migrating ground gases to end users via unsealed or poorly de-commissioned boreholes is referenced in the document. Gas monitoring wells, should also be referenced in this context.

However, it should be noted that any ground gas migration pathways will also be open to Radon. The health issues associated with Radon contamination in the UK are currently receiving greater regulatory focus and radon should have been referenced in the document.

I also take issue with the statement included in **Section 11.2.1** Specific problems and uncertainties. In this section it states:

> *Other issues such as "pile whip" referred to in the previous version of this report are now known to not be an issue with respect to ground gas.*

While the creation of an annulus by pile whip may be uncommon, it can occur and particularly where there is a surface cohesive layer overlying a ground gas source or gas

migration pathway. Such an annulus is demonstrated on the front cover of the recent NHBC NF94 guidance document[2].

'Pile whip' is also referenced in the Coal Authority's[3], guidance on managing the risk of hazardous gases when drilling or piling near coal[4]. In Section 6.4.3 Driven piling, of this document it states:

> *Where the pile driving is protracted due to the slow progress of the pile there is potential for a limited pathway to arise due to the small lateral movement of the pile, known as pile whip.*

Section 14 summarises the pollution scenarios in a table with risks classed between A – Negligible to D - High Risk.

With regard to ground gas hazards, Scenarios 5 and 6, most of the piling techniques are classed as A: Negligible risk, irrespective of the ground conditions. A: is classified as:

> *- Pollution scenario not likely to be an issue if using this method provided workmanship and QA/QC measures are appropriate.*

However, it should be noted that higher risks may exist on certain sites where ground gas migration pathways may be intercepted by the piling and appropriate workmanship or QA/QC are not provided. Sadly it is dangerous to assume high professional standards and QA/QC are always present. and I would have preferred for Scenario 5, driven piles to be classified as B – Low Risk.

Section 16.3 discusses gas monitoring. And states:

> *On the majority of development sites gas monitoring is not normally required during or after pile construction. In some high risk scenarios it may be prudent to undertake gas monitoring around the top of piles (e.g. where piles penetrate through a thin confining layer into a gas source that is under pressure and generating large volumes of gas, such as recent domestic landfill or where mine gas could be present in open voids close to the underside of the piles or ground improvement).*

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[2] https://www.nhbc.co.uk/foundation/hazardous-ground-gas
[3] From 28 November 2024 the Coal Authority was rebranded as the Mining Remediation Authority
[4] https://www.gov.uk/government/publications/guidance-on-managing-the-risk-of-hazardous-gases/guidance-on-managing-the-risk-of-hazardous-gases-when-drilling-or-piling-near-coal

Within **Appendix 1**. Literature review, the Wilson and Mortimer (2017) document is referenced (A1.4). This discusses, the preferential pathways for ground gas migration around piled foundations. In respect of the risk associated with driven piles, it states:

> *Where gas flow is driven by pressure, the gas flows may be greater than flow by diffusion. Pile spacing again is a critical factor as well as the horizontal permeability of the ground which affects how fast gas can migrate from the gas reservoir to the piles.*

And

> *One of the most common causes of whip in slender piles in the past has been overdriving in hard ground conditions. Other causes have been driving into stiff over consolidated clays, incorrect alignment of the piling hammer and use of raking piles (not likely in development sites). Whip can be avoided by good installation practice and avoiding use of driven piles in unsuitable ground conditions.*

My concern is associated in those situations where pre-cast driven piles are 'over-driven' on ground gas contaminated sites where pressure driven flow is dominant and the gas reservoir is relatively large (or has the potential to store ground gas).

It is recognised that these circumstances may be uncommon. However, where an annulus is formed on a ground gas contaminated site it should not be discounted or overlooked. Such an annulus, inadvertently created due to poor practice or unexpected ground conditions, should be identified through quality assurance and site monitoring and appropriately remediated. Where a pile whip annulus is formed, it can be easily sealed by grouting it up with bentonite slurry and ideally form part of the general piling procedure.

I disagree with the thrust of the stone column discussion points that downplays the increased ground gas migration risk that this ground improvement technique creates. If vertical stone columns are created using single size stone within lower permeability soils, then a preferential pathway will be created. Indeed, this technique has been used in the past to safely vent landfill gas to atmosphere. It was also a pathway highlighted in the Gorebridge incident and has also been identified as a pathway in other projects GGS have been involved with.

It should be recognised that in any discussion about the permeability of soils that natural geological deposits will have a fining upward sequence that creates a dominant horizontal permeability. A dominant horizontal permeability is also present in all made-

ground deposits that are laid down and compacted in layers. Higher permeability vertical stone columns, inserted into such soils will dramatically change their permeability characteristics.

Also, I suggest that it is better to avoid an increased risk of vertical gas migration to the underside of a building then having to design some form of enhanced building envelope gas protection. Avoiding creating a potential hazard is better than trying to manage a hazard you have created is one of the guiding principles of health and safety.

Conclusions

The CL:AIRE guidance is a good document that discusses the contamination issues associated with the wide range of piling and ground improvement techniques. However, in my opinion, there are a few areas where real risks associated with ground gases are not adequately addressed.

Ultimately, it is the site-specific ground conditions, structural details of the development and requirements of the end users that will determine the most appropriate foundation design. I'm very conscious that in too many cases in the past, these elements have been considered separately without experienced holistic oversight.

However, the final challenge is for the development to be constructed as designed. This can only be achieved by appropriate quality controls. Sadly, these have not always been in place.

This document improves the understanding of the potential contamination issues associated with piling and ground improvement techniques. However, I would apply 'the precautionary principle' and not assume quality control and good professional practice is always in place.

Authored by Simon Talbot

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