

Feasibility Check Soil Stabilisation

Mr Rob Bramley - 23 Oakfield Walk, Barnsley, S75 2LW



Brief history of the Claim

The subject property is a two-storey detached house built circa 1950. Extensions were added to the right side and rear of the property in 2012.

The damage is located throughout the extensions to the property, affecting external brick walls and internal rooms at ground and first floor level. Damage is also located mainly towards the rear and rear left corner of the property.

The property was purchased by the Policyholder and occupier in 2018. Household residential building insurance commenced with Lloyds Banking Group ('LBG') on 02 July 2018.

The Policyholder notified a claim following the discovery of movement in September 2018. The current Insurer LBG appointed The Innovation Group ("IG") to assist with the claim. IG undertook site investigations and established that the cause of the movement was continued tree root induced clay shrinkage subsidence. An Oak tree (T1) and Willow tree (T2) belonging to a Third Party neighbour were implicated as the cause of the subsidence.

Damage has continued to progress at the property and this was confirmed through a period of level monitoring that was undertaken between December 2020 and May 2023.

The implicated Oak and Willow trees are covered by Tree Preservation Orders. Efforts to obtain agreement from Barnsley City Council to remove their implicated trees failed.

The content of this Feasibility Check outlines the measures proposed to respond to the presence of the vegetation to the left of the property adopting a response proportionate to the circumstances giving rise to the problem as a whole.

Soil Stabilisation Barrier October 2018 rev1

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Vegetation and Arborist requirements.

The remaining trees believed to be the cause of the problem are:

Tree species	Current Height	Mature Height	Distance	Water Demand	Owner
T1 - Oak	15.2m	24m	18.2m	High	Neighbour
T2- Willow	15.2m	24m	15.7m	High	Neighbour

Do any of the trees have TPO's or conservation restrictions: **Yes**

Site Data for Soil Stabilisation

Category of damage (in accordance with table 1 BRE digest 251)			Cat 1-5 3			
Area of Damage	Main House	Extension	Garage	Outbuilding		
	Yes	Yes	No	No		
Cracking is both internal and external predominantly to the front left corner of the main house.						
	Crack monitoring	Maximum Opening	Maximum Closure	Level Monitoring	Maximum Downward Variation	Maximum Upward Variation
	No	N/A	N/A	Yes	40mm	10mm

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CLAY SOILS

Samples from BH3

Lab Ref	Depth (m)	WC (%)	LL (%)	PL (%)	PI (%)	.425 mm(%)	mod. PI (%)	Av. Suc. (kPa)	Description
1	0.3	26.1	60	20	40	100	40		Stiff orange-brown/light grey mottled silty CLAY with rare gravel. Gravel is fine and medium.
2	0.8	26.3	60	20	40	100	40		Firm to stiff orange-brown/light grey mottled silty CLAY with rare gravel. Gravel is fine
3	1.2	20.6	57	18	39	100	39		Stiff dark grey silty CLAY with rare gravel. Gravel is fine
4	1.7	22.2	57	18	39	100	39		Stiff dark grey silty CLAY with rare gravel. Gravel is fine

BH3 located to the rear left corner of the property

Samples from BH4

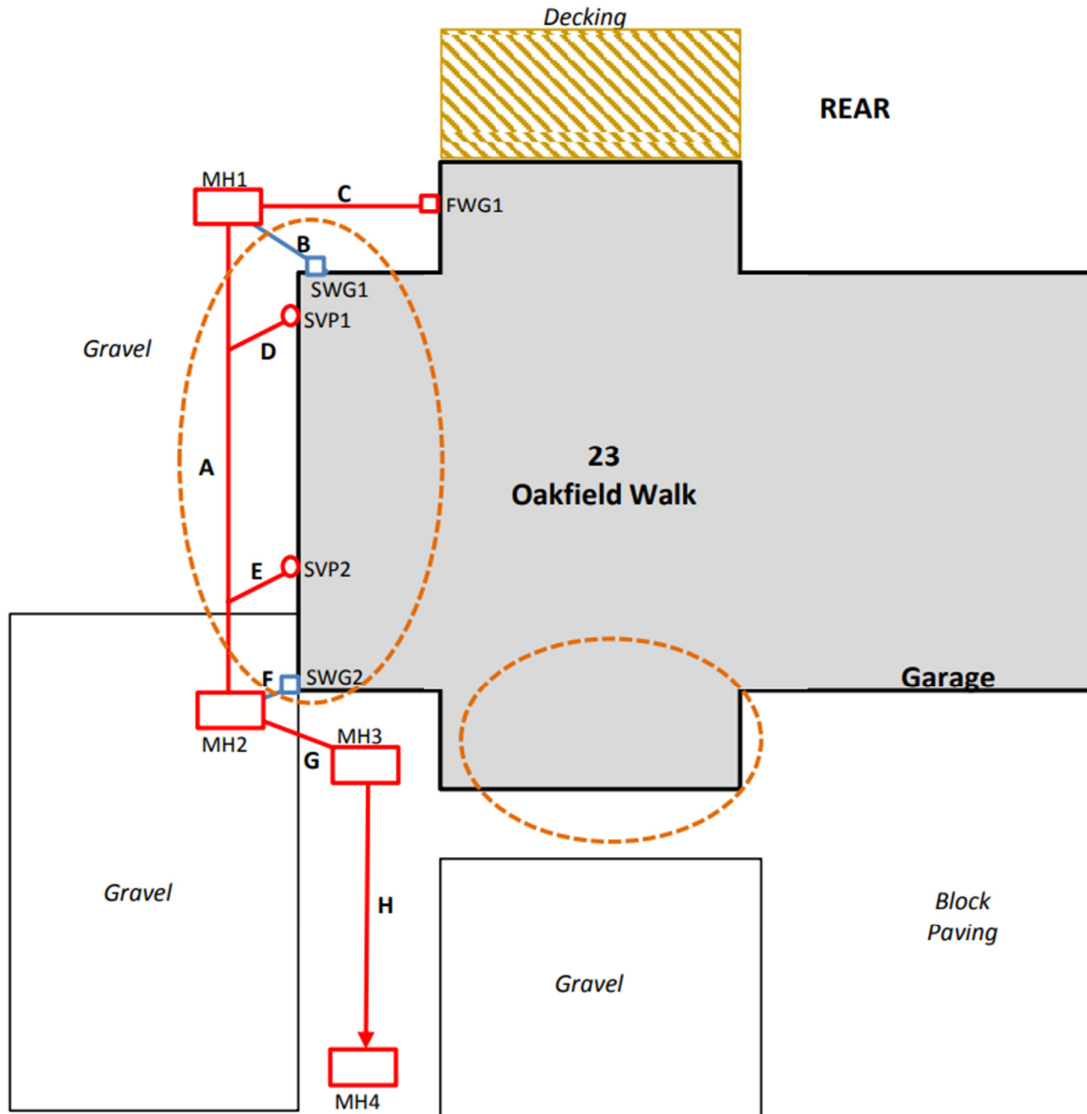
Lab Ref	Depth (m)	WC (%)	LL (%)	PL (%)	PI (%)	.425 mm(%)	mod. PI (%)	Av. Suc. (kPa)	Description
5	0.3	24.7	68	22	46	100	46		Firm to stiff orange-brown/light grey mottled slightly silty CLAY with rare gravel. Gravel is fine
6	0.9	23.8	65	20	45	90	41		Firm to stiff dark grey slightly gravelly silty CLAY. Gravel is fine.
7	1.4	15.1	65	20	45	90	41		Firm to stiff dark grey slightly gravelly silty CLAY. Gravel is fine and medium.
8	1.9	12.4	65	20	45	90	41		Firm to stiff dark grey slightly gravelly silty CLAY. Gravel is fine and medium.

BH4 located to the rear right corner of the property

CCTV survey completed **Yes** ****Defects to Run H which is located to the front of the property and away from the area of damage.**

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Has the property been underpinned previously ?

No

If yes, please state the type, depth and location

Is the property in a conservation area?

No

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Why have we recommended an Intervention Technique?

Damage at the property has been investigated, and the affected parts of the building are known to be suffering from clay shrinkage subsidence. The cause of the problem is Third Party neighbour owned Oak and Willow trees located within the rear garden of the property. The vegetation is unable to be removed.

The physical location of the identified vegetation is ideally suited to Soil Stabilisation Techniques. The following details confirm the mechanism mitigating against the influence of the vegetation reducing foundation movement and restoring relative stability.

How does Root Management and Soils Stabilisation work?

In the UK the shrinkage and swelling of clay soils, particularly when influenced by trees, is the single most common cause of foundation movements that damage low rise buildings.

Trees are known to cause clay soils to shrink by drawing water through their roots, predominantly during spring and summer. This shrinkage results in both vertical and horizontal ground movements, that when transmitted to a building's foundations, cause damage to the building structure.

The amount of shrinkage depends on the characteristics of clay soil, the type and size of vegetation, plus variations in climate. Trees growing under grass cover are forced to compete for their water and to extract water from greater depths than they might otherwise do, as is the case in this instance.

The water content of a shrinkable clay soil will vary with depth remote from and near to a large tree. Near the ground surface there can be relatively large changes in soil water content between summer and winter as a result of evaporation from the ground surface and transpiration by the grass. Such variations are normally confined to the top 1m of the ground, possibly less adjacent to buildings. Where mature trees/vegetation grow at the same location, then the water-content profiles will vary and the seasonal fluctuations in soil water content are both larger and extend to greater depths. Soil volume changes and hence ground movements with attendant subsidence damage to low rise structures will thereby be greater.

Soil Stabilisation

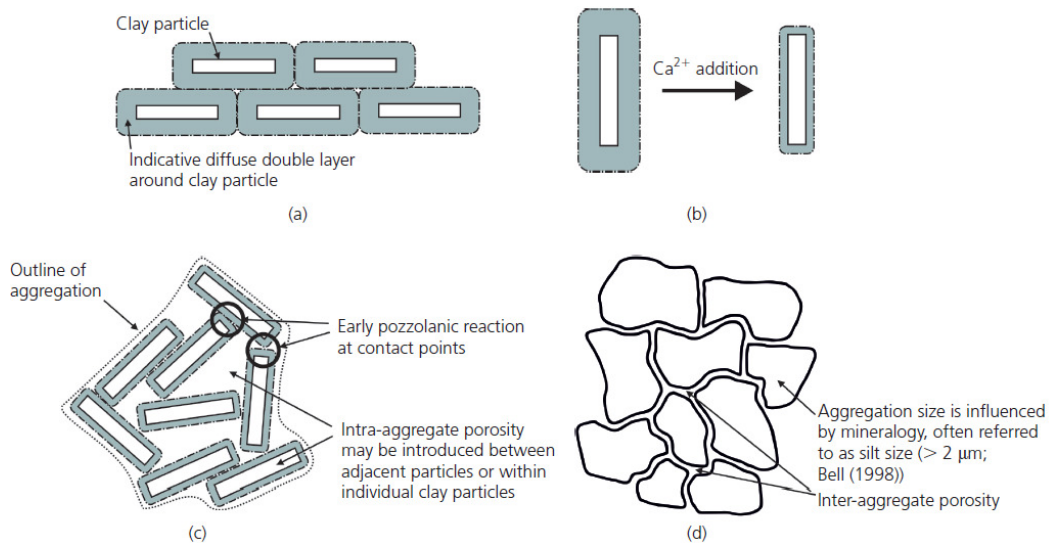
Subsidence cracks arising in summer months due to shrinkable clay subsoils will close when ground moisture contents recover over subsequent winter periods. The intention of the Soil Stabilisation Method is to mitigate against this periodically damaging effect. The solution adopted in this case introduces a naturally occurring mineral at the surface of the clay particles which decreases their volume change potential. Thus, decreasing water uptake by the trees and thereby lessening subsidence risk conserving soil moisture beneath the foundations and reducing clay shrink/swell effects. The benefits here are also seen here in severing the existing roots and then restricting their future growth potential by the creation of environments inhospitable to their re-development.

In addition, the shrink/swell properties of clay subsoils are limited by the introduction of lime additives thus reducing both plasticity and volume change potential. Consequent cation exchange/clay aggregation reduces the clay mineral effective surface area and affinity for water.

Cation exchange leads to soil property changes resulting in the modification of the clay structure mainly involving calcium ions and is regarded as a rapid cation exchange process occurring on the surface of clay particles. Clay particles typically exhibit surface charge imbalances and the negative charges are balanced by hydrated cations. Accordingly, individual clay particles are surrounded by adsorbed water in the diffuse double layer arrangement (Van Olphen, 1977).

Feasibility Check Soil Stabilisation

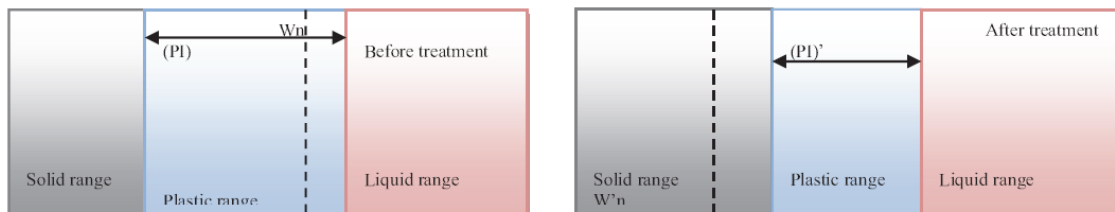
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The thickness of the diffuse double layer is controlled by several factors (Reeves et al., 2006) although the valence of the charge-balancing cations has primary influence. Incoming divalent cations exert a greater attractive force towards the clay particle surface than any monovalent cations (which are common to natural clay soils). This balances the clay surface charge with fewer hydrated cations and the thickness of the diffuse double layer shrinks in response (Bohn, 2002). As the diffuse double layers shrink, the electro-static charges on adjacent clay particles interact to a greater extent.

Opposing negative charges of parallel aligned (face to face) clay particles are repelled and reconfigure to promote a flocculated, positive/negative charge (e.g. edge to face) arrangement. This causes silt-sized aggregations of clay particles to group together (Bell, 1996) and two influences on the clay soil structure are suggested: an increase in micro-porosity, intra-aggregate to the flocculated particles and a change to the meso-porosity, inter-aggregate to the flocculated particles. This reduces the effective surface area of clay minerals in contact with the inter-aggregate pore water accounting for much of the immediate change in physical properties of the clay soil associated with lime improvement.

Effect of liming on the consistency of soil



Soil pH directly affects the life and growth of vegetation because it directly affects the availability of *all* plant nutrients. A nutrient is in its most available state between pH 6.0 and pH 6.5. A nutrient must be soluble long enough and remain soluble long enough to successfully travel through the solution into the roots. Nitrogen for example has its greatest solubility between soil pH 4 and soil pH 8. Outside of that range its solubility is seriously restricted. The usual recommendation in order to raise the pH of soils is the application of lime. Clay soils are typically neutral displaying a pH of 7; as mentioned previously the pH value of a soil has a huge influence on what plants will grow. The addition of lime and consequent raising of the pH value will moreover limit the extent to which vegetation develop in the zone of soil stabilisation.

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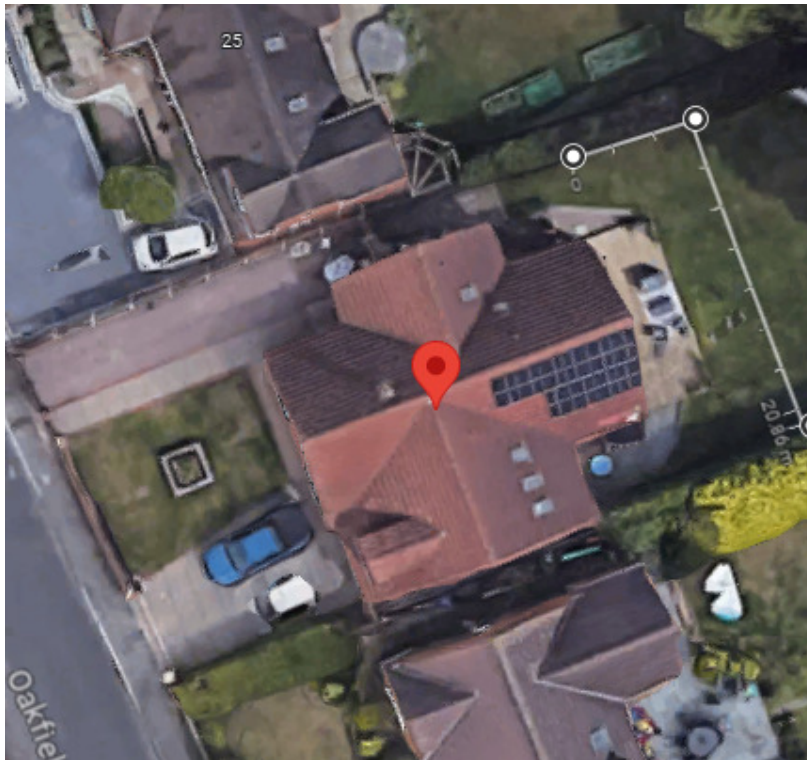
Conclusion

- Lime is used as an excellent soil stabilising material for active clays which undergo frequent volumetric change through shrinkage and swelling
- Lime acts immediately and improves various soil properties of the clay such as bearing capacity, resistance to shrink/swell during seasonal climatic changes, reduction in Plasticity Index, provides an environment hostile to root growth
- The reaction is very quick and stabilisation of soil starts within a few hours
- Provides a valuable modification to the behaviour of tree roots whilst enabling the vegetation to be retained in place
- Provides tangible sustainability benefits enabling trees to be retained rather than removed
- The presence of lime does not constitute an eco-system burden or impact on ground water

Specification of Soil improvement				
Stabilisation Type	length	Max Root Depth	Depth of stabilisation	Distance between tree / Vegetation and barrier
Lime Barrier	17m	2.1m	20m	Approx. 9m distance from barrier to centre of T1 – Oak. Barrier to run across rear garden lawn from left to right boundary. Access to be provided from property at rear during installation of a separate root barrier.

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General Schematic

Lime soil improvement channel to be installed as shown opposite in order to intervene successfully between the tree and area of damage.

All existing surfaces will be re-instated and surface protections will be maintained throughout the course of the works.

Barrier length approx. 17m (See later opposite)

Additional Items

1. Line searches to be carried out to establish any services in the area for the proposed barrier however cat and jenny scans are still required.
2. Root severance application to be made to Barnsley City Council and approval to be agreed before barrier can be installed in respect of T2 Willow. T1 is being removed as part of a separate agreement.

