Feasibility Check Soil Stabilisation

Mr A Rogers 10 The Close, Uxbridge, Middlesex UB10 0BP

Brief history of the Claim

The Damage was first noticed during the summer of 2018 with cracking discovered both internally and externally to the front elevation.

Initial proposals sought the removal of the mature vegetation to the front of the property within a protected area of vegetation. Applications to the Local authority resulted in refusal to undertake any tree removal.

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

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
T3 Oak	18m	20m	15.9m	High	Local Authority
TG2 Mixed Oak, Sycamore	16m	20m	12.3m	High	Local Authority

Do any of the trees have TPOs or conservation restrictions: Yes

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Site Data for Soil Stabilisation

Category of damage (per table 1 BRE digest 251)	**Cat 1-5**	**2**

Area of Damage	**Main House**	**Conservatory**	**Garage**	**Outbuilding**
	Yes	**No**	**No**	**No**

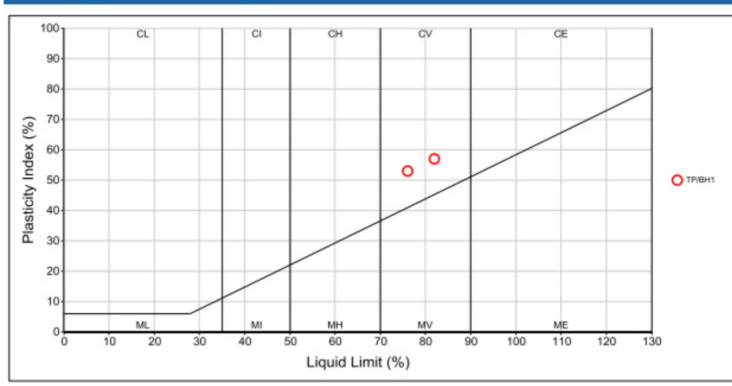
Crack monitoring	**Maximum Opening**	**Maximum Closure**	**Level Monitoring**	**Maximum Downward Variation**	**Maximum Upward Variation**
No	***n/a***	***n/a***	**Yes**	**-1mm**	**8mm**

CLAY SOILS –*Sandy CLAY*

Lab Ref	Depth (m)	MC (%)	Corr MC (%)	LL (%)	PL (%)	PI (%)	% Passing .425mm
Samples from TP/BH1							
001	2.00	26	26	82	25	57	100
002	2.50	26					
003	3.00	23	23	76	23	53	100
004	3.50	25					

Lab Ref	Depth (m)	Description	BS:5930	NHBC Chapter 4.2
Samples from TP/BH1				
001	2.00	Stiff brown CLAY with rare gravel. Gravel is fine	CV	High
002	2.50	Stiff brown CLAY with rare gravel. Gravel is fine		
003	3.00	Stiff brown CLAY with rare gravel. Gravel is fine and medium.	CV	High
004	3.50	Stiff brown CLAY with rare gravel. Gravel is fine and medium.		

Plasticity Chart for Casagrande Classification



<u>Tree Roots Recovered to 2.3m</u>

CCTV survey completed **YES**

Has the property been underpinned previously? **Yes – Geobear type injection which has failed**
If yes, please state the type, depth and location
Is the property in a conservation area? **No**

Soil Stabilisation Barrier October 2018 rev1

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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 trees located within the local authority land at the front of the property.

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.

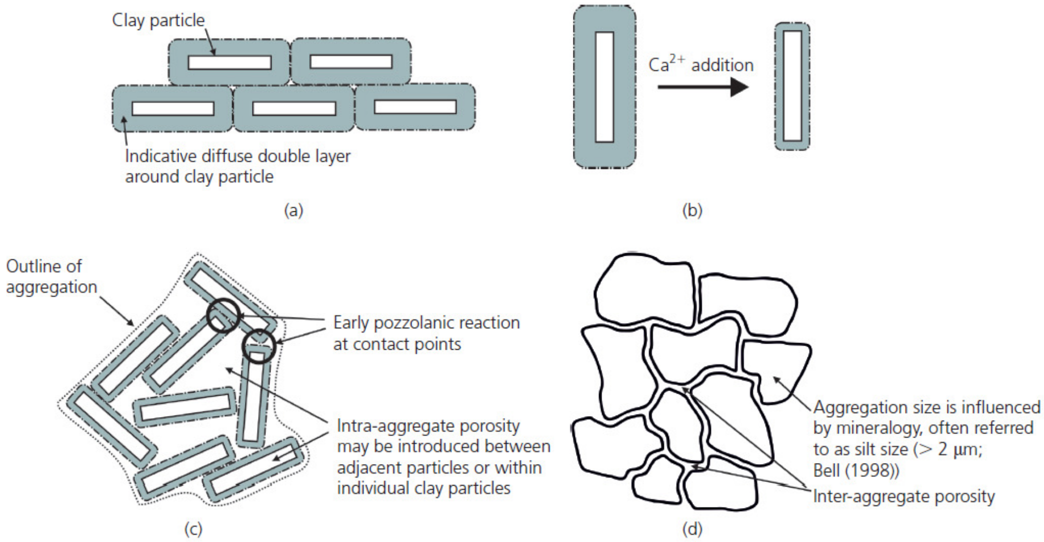
The water content of a shrinkable clay soil will vary with depth remote from and near to a large tree. Near the ground surface, there can be relatively large changes in soil water content between summer and winter as a result of evaporation from the ground surface and transpiration by the grass. Such 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 the summer months due to shrinkable clay subsoils will close up 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.

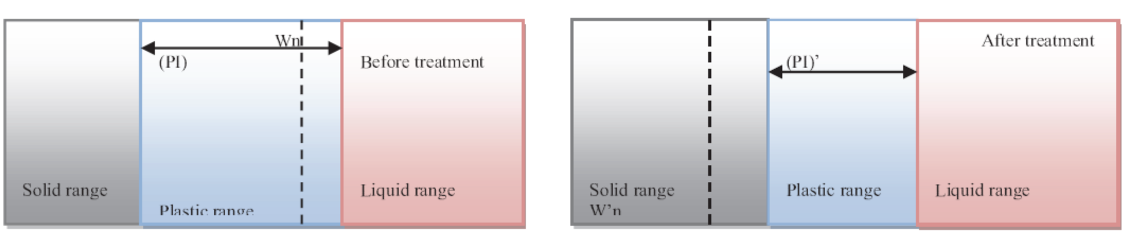
Cation exchange leads to soil property changes resulting in the modification of the clay structure mainly involving calcium ions and is regarded as a rapid cation exchange process occurring on the surface of clay particles. Clay particles typically exhibit surface charge imbalances and the negative charges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



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 mesoporosity, 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 pH8. 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 groundwater

Specification of Soil improvement				
Stabilisation Type	length	Max Root Depth	Depth of stabilisation	Distance between tree / Vegetation and barrier
Lime	20m	2.3m	3.0m	As dictated on-site – the underside of foundations is 2000mm bgl

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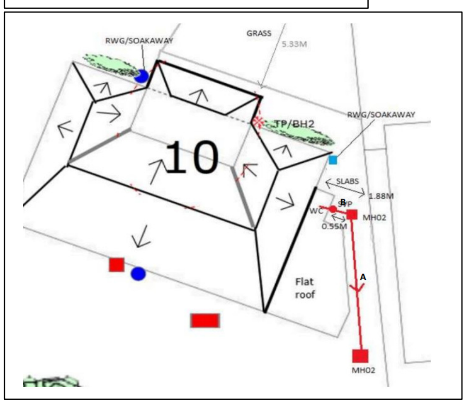

General Schematic

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. 20m (See later opposite)

Additional Items

1. **All surface treatments to be replaced as they were found**

2. **Care to be taken to the left hand side of the property and the retaining wall to the garden.**

 # Example photos below