



Claim and
Risk Solutions

ANALYSIS OF SITE INVESTIGATION DATA

Client Name	Interested Underwriters Per Direct Group
Reference	GB024843
Name of Insured	Mrs Julie Girling
Policy Number	BDBR101029
Risk Address	School Bungalow, Erskine Road, Vigo, Gravesend, DA13 0RL



GHG Reference	L/2018/53447/S
Date of Report	13 January 2023

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1. Introduction

We have been asked to investigate damage around the rear right of the above property and this Report is issued following the receipt of site investigation data. The property was the subject of subsidence damage in 2018, which was repaired in July/August 2021 and this investigation was carried out following a reoccurrence of the damage in 2022.

50 mm diameter disturbed soil samples were retrieved from the borehole that was sunk through the trial hole excavated against the right hand side of the rear elevation of the property on 02 December 2022.

The samples were deposited with a testing laboratory with instructions to determine

(a) the index properties of the soils and

(b) the soil suction pressures.

Roots retrieved from the trial hole/borehole were also retained for laboratory identification.

The purpose of these tests is to establish whether the soils exhibit any signs of root or drought induced desiccation, and if so, whether the potential exists for significant progressive movement.

2. Soil Properties

The retrieved soil samples have been tested by an independent testing laboratory and this has revealed that they have what are known as highly to very highly plastic plasticity index properties.¹

As an example, in the sample taken from Borehole number 1 at 1.10m below ground level, which is the underside of the foundation, the liquid limit is shown to be 66%, the plastic limit is 29% and the plasticity index (which is the difference between the two) is 37%.

As a further example, in the sample taken from Borehole number 1 at 2.0m below ground level the liquid limit is shown to be 80%, the plastic limit is 36% and the plasticity index (which is the difference between the two) is 44%.

Higher plasticity clays, similar to London or Weald type, generally show they have high to very high potential for volumetric changes in relation to the moisture content. That is, they shrink when moisture content is reduced and swell when the moisture content is increased.

In this case, a very silty clay was noted, which is highly to very highly shrinkable with a moderate to high potential for volumetric change in relation to moisture content. Silty clays are also liable to rehydrate faster during wetter weather than pure clays due to large particle size of silts allowing the water to penetrate the soil matrix more effectively.

There is little doubt that the prolonged dry weather experienced during much of 2022 would have had an effect along with nearby trees.

¹Table 1, Chapter 4.2, Para 2.3 of N.H.B.C. Standards, 1986.

3. Moisture Content

Using criteria put forward by Driscoll² it is suggested that clay soils are desiccated if the moisture content is less than 40% of the liquid limit. In addition he suggested for certain clays only that a further indicator of desiccation exists if the moisture content is less than 2% above the plastic limit.

The latter method is rarely used, however, as it applies to certain clays only and also the method of determining the plastic limit is less reliable than the method of determining the liquid limit.

In this case the lowest moisture content is seen to be 34.2% in the sample taken from Borehole number 1 at a depth of 2.0m below ground level.

This is not less than 40% of the liquid limit (80% x 40%) being 32%, which suggests that the soil in this area was not desiccated at the time of the site investigation on 02 December 2022. Examination of the remaining samples shows no evidence of desiccation at the time of testing. However, this does not imply that the clay was not desiccated at the time of the damage to the bungalow reoccurring during the summer of 2022.

² Driscoll (1983) "The Influence of Vegetation on the Swelling & Shrinking of Clay Soils in Britain". Geotechnique. Vol. 33.

4. Suction Values

The structure and nature of clay soils is such that they constantly strive to achieve an “equilibrium” moisture content. This is usually recorded, in disturbed samples, as a suction pressure of approximately 100kPa. When a soil is drier than this equilibrium moisture content the internal soil suction pressures increase.

Measuring these negative soil pressures is a useful measure to indicate any level of moisture deficiency.

Higher suction pressures indicate drying of the soil and this usually results from one, or more, of the following reasons.

Firstly, evaporation, in the absence of roots from adjacent vegetation this is usually confined to the top 1 metre of soil as a maximum. The suction values would be highest in the upper levels of soil and would decrease with depth to areas where the evaporation effects were minimal.

Secondly, when clay soils overlie sands or porous stone, some under-draining may take place. That is, moisture within the soil may be allowed to escape through the natural porosity of the underlying soil. This usually produces a suction pressure graph which increases gradually and in a linear fashion with depth. The suction pressure would reach a maximum at the junction between the upper clay soil and the lower porous soil.

A third cause of negative pore pressures involves sloping sites. Clearly, on a sloping site there is a tendency for moisture to move through gravity to other areas. This generally reveals a graph in which the suction pressures are high at upper levels but decrease with depth.

Finally, root induced desiccation can produce very high suction values. The graph of suction pressure against depth generally tends to bulge at the area of peak root activity. The roots may emanate from adjacent vegetation such as bushes, ivy and roses or more significantly from adjacent trees. The graph can vary quite considerably and is dependent upon the age, species and proximity of the tree, the time of year and the prevailing weather conditions.

Trees typically produce the maximum root effect at a depth of between 2 and 4 metres below ground level. Shrub, bush and rose roots often produce effects between 0 and 1.2 metres below ground level.

Suction pressures vary as a result of a number of physical conditions but generally shrubs can be expected to produce pore suctions of around 300kPa, whilst mature trees can induce suction pressures up to 1,000kPa.³ Suction pressures above 1,000kPa must be treated with caution. They are indicative of high suction and therefore soil desiccation but precise reliance on the suction figure achieved should be avoided.

The interpretation of a graph of suction pressures must therefore be based on experience and knowledge of the site conditions and the time when the samples were taken.

Evidence from Borehole 1 located against the right hand end of the rear elevation indicates very slight to slight desiccation to a depth of at least 2.0m below ground level,

³ Hsiao (1973) “Plant Response to Water Stress” Ann. Rev.Pl.Physiol. Vol.24.

suction testing not being possible at greater depth due to insufficient sample size. The suction values indicate the influence of nearby vegetation.

5. Heave Potential

It is slightly overstated to suggest that soil mechanics is a science. Purely because of the variable nature of the soils and the environment in which they exist any estimate of heave must be at best little better than a guess.

London clays tend to be more homogenous than other clays found in the south of England and most current research has been conducted in the South-East area of England. Estimates of heave used in the compilation of this Report are based upon a design guide put forward by M. Crilley⁴ for discussion purposes only.

In this case, following the original episode of subsidence damage in 2018, an heave calculation was carried out based upon the soil sample test results at that time. The suction values in 2018 were significantly higher than the current values yet the heave potential was calculated to be low at that time. Given that the suction values on this occasion are significantly the heave risk is therefore even lower.

This indicates that there is a very low risk of any damage due to heave occurring if the influential trees are removed.

⁴ Crilley. M., Foundation Engineering Department, B.R.E., Garston. Personal Communication.

6. Root Identification

At the time of excavating the trial pit and borehole a number of root samples were taken for identification analysis. These have been sent to an appropriate specialist and we have now received the results which indicate that the roots belong to an Oak tree situated in the rear right of the rear garden to the risk address, 7m distant from the rear right of the bungalow and also to an Alder situated on Council owned land to the rear right of the risk address, at a distance of 9m from the rear right corner of the bungalow. The Oak tree currently stands at a height of approximately 11m whilst the Alder stands at a height of approximately 20m. The oak tree previously stood at a height of 14m and was reduced by the policyholders after the original episode of subsidence in 2018. We are not aware of any works carried out to the Alder by the Council.

Root Number	Borehole	Depth	Root Type
1	1	1.1m - underside of foundation	Probably <i>Alnus spp.</i> but possibly <i>Betula spp.</i>
2	1		<i>Quercus spp.</i>
3	1		Probably <i>Alnus spp.</i> but possibly <i>Betula spp.</i>

Alnus are alders whilst *Betula* are birches. In the absence of any birch trees in the vicinity of the current subsidence damage to the bungalow, we can conclude that these roots are from the large Alder tree situated approximately 9m distant from the rear right of the bungalow on land to the rear.

Quercus are oaks and must emanate from the oak tree to the rear right of the rear garden of the risk address.

7. Discussion

- a) The results of the site investigation confirm the presence of an highly shrinkable silty clay subsoil with elevated suction values to at least 2.0m depth and 6mm diameter roots identified as alder and oak found at the underside of the foundation and to a depth of 1.5m below ground level in the borehole at the rear right of the bungalow and hair like roots present to a depth of 2.0m below ground level.
- b) Whilst there was no evidence of a moisture deficit in the samples retrieved on 02 December 2022, there are elevated suction values to a depth of 2.0m below ground level that coincide with the doeth to which roots were found and confirm the influence of the oak and alder trees.
- c) In view of these results we are satisfied that the recent damage around the rear right of the bungalow, which occurred during the summer of 2022, is a reoccurrence of the damage that occurred in 2018 and is as a result of clay shrinkage subsidence due to the influence of both the oak and alder trees.
- d) In 2018, oak roots were not found in the borehole beneath the foundation to the area of damage to the bungalow. Alder and hornbeam roots were present. The hornbeam roots emanated from a clump of trees in the rear of the policyholder's garden and, following receipt of arboricultural advices, these trees were removed.
- e) Vigo Parish Council were notified of the damage to the bungalow and the evidence implicating their alder tree was provided to them. The arboricultural advice was that the alder tree should be removed. However the Council chose not to undertake any works to this tree.
- f) Despite no roots from the oak being found, the policyholders undertook to carry out a crown reduction of their oak tree to help reduce the overall moisture uptake by the vegetation.
- g) Unfortunately it is clear that the influence of the oak and alder trees is such that their continued presence poses a very high of causing repeat episodes of clay shrinkage subsidence to the risk address in the future.
- h) As both trees are subject to tree preservation orders, the co-operation of the council is required before any works to the trees may be carried out.
- i) We are confident that, if the trees are removed, relative stability of the bungalow will be restored without the need for substructure stabilisation. This may be confirmed by monitoring.
- j) However, if the trees remain, there is no other option than to carry out substructure stabilisation of the affected part of the bungalow to mitigate against the influence of the trees.

8. Recommendations

- a) We believe that the appropriate remedial action on this occasion is to arrange for the oak tree in the rear right of the policyholder's garden and the alder tree situated on council land to the rear right of the property to be removed.
- b) It will now be necessary to remove the vegetation at the earliest possible time and certainly before the onset of the growing season in the spring.
- c) We will continue to monitor the property on a regular basis to establish whether any significant recovery occurs particularly once the cause, the trees, has been dealt with and to determine whether the property stabilises before the necessary repairs are carried out.
- d) Should the trees remain, given the high risk of repeat episodes of clay shrinkage subsidence then occurring, it will be necessary to implement a scheme of substructure stabilisation.

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Enc. Geotechnical Survey Report 25382:-

- 1. Soil Results, including Graphs
- 2. Tree Root Identification Results
- 3. Site Plan