The Clay Research Group

RESEARCH AREAS

Climate Change ◆ Data Analysis ◆ Electrical Resistivity Tomography
Time Domain Reflectometry ◆ BioSciences ◆ Ground Movement
Soil Testing Techniques ◆ Telemetry ◆ Numerical Modelling
Ground Remediation Techniques ◆ Risk Analysis
Mapping ◆ Software Analysis Tools

The Clay Research Group
www.theclayresearchgroup.org

April 2008

The Clay Research Group

Diary

Many thanks to the technical team at HBOS for their invitation to talk about our work at their training conference.

Neil Curling, Steve Wright and Frank Russell are organising the day and we will be talking about PRD and LiDAR.

Glenda Jones has agreed to deliver a lecture to the students at Aldenham School in June outlining our work, and maybe adding the issues faced by a PhD student.

Glenda is currently writing up the results of her research at Aldenham, - an extract appears in this edition.

Richard is chairing the annual subsidence conference at Aston on the 12th June, as well as delivering a talk entitled, "Investigations – do they add value?" Richard will be joined by Peter Osborne, BGS, Plexus Law, Paul Thompson and others.

Stephen Plante will be talking about risk modelling at the MapInfo/Pitney Bowes conference on location intelligence at the NEC in Birmingham on the 29th and 30th April.

Tony Boobier is the EMEA strategic manager for Pitney Bowes and will be explaining the findings of the Pitt Report.

With the help and guidance of our research partners at Keele University we have applied for grant funding under the Index scheme to develop further the numerical modelling application to simulate the effect of moisture abstraction from clay soils by root systems.

Alan Bates is leaving MatLab after seven years running their laboratory.

He has been involved with the soils testing at Aldenham and taken a lead role in our research into the use of disturbed samples using the oedometer.

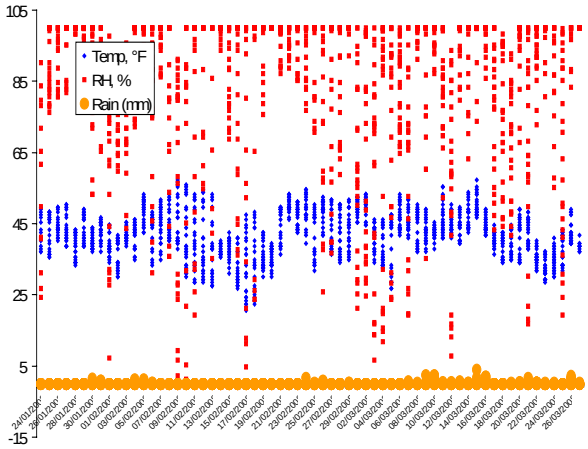
Estimated Root Zones

Our 'estimated root zone' is constantly under review and comparisons made with actual claims to ensure that it is robust. The model doesn't pretend to estimate where the roots are, but where they exert an influence on the ground sufficient to cause damage to a building.

The image above shows this estimated zone of influence extends beneath many buildings, but only some suffer damage. See article on Pages 5 & 6.

Weather Watch

Below is the data from the weather station at the Aldenham Research site for February and March 2008. Fairly low rainfall (orange dots) and fluctuating temperatures (blue dots).

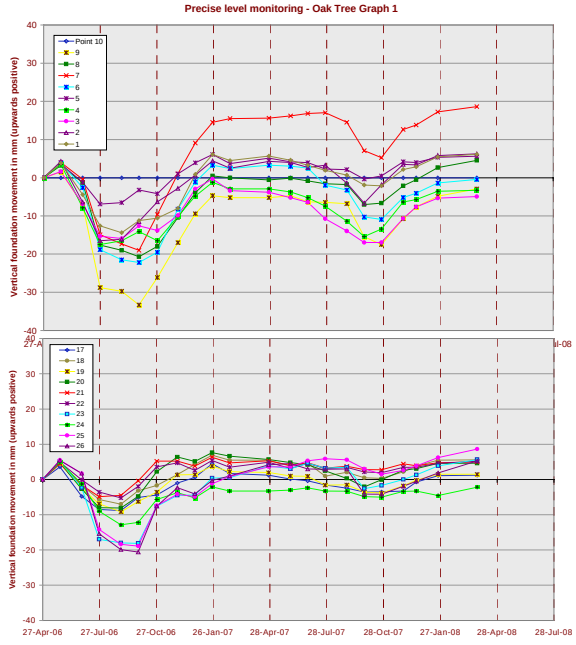


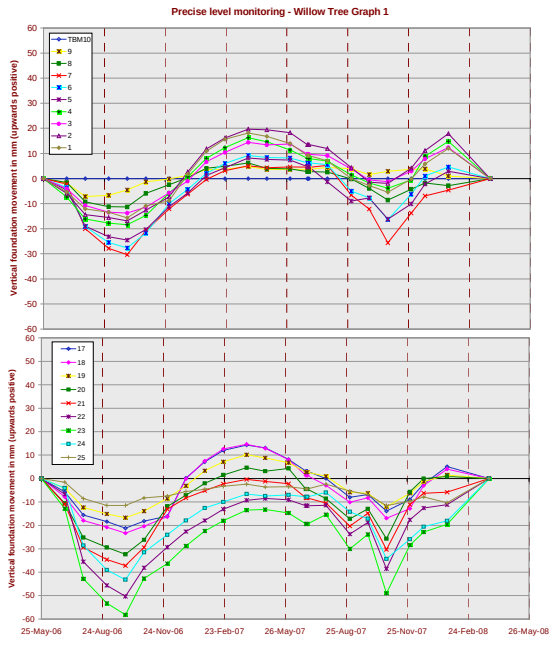
The Met Office web site (www.metoffice.gov.uk) forecast is … "temperatures are more likely to be above the 1971-2000 average. However, there is a slightly enhanced chance of cloudier and cooler spells. Rainfall is more likely to be either near average or above average. The risk of exceptional rainfall, as seen last summer, is assessed as very low at this stage."

The Clay Research Group

Precise Levels

GeoServ have plotted ground movement in the vicinity of the Oak (left) and Willow (right) at Aldenham from April 2006 through to the end of March 2008. The Willow readings started a month later in May 2006.



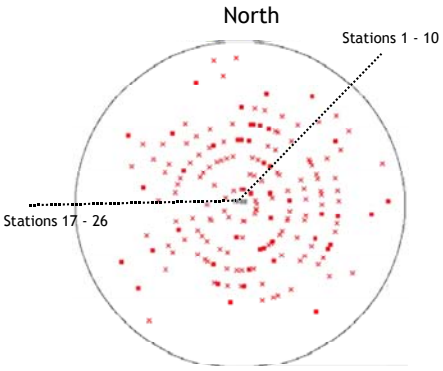


The red line (Station 7 – Oak - top left-hand graph) suggest there was a persistent deficit through the winter of 2006 which has since replenished itself. Total movement for the Oak is 40mm and for the Willow, 60mm. The soil beneath the Oak is a heterogeneous mixture with pockets of sands and gravels whereas the soil beneath the Willow is a more consistent clay.

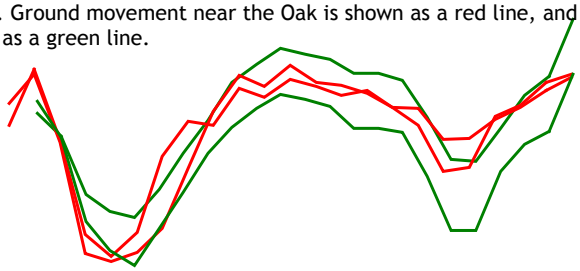
Maximum movement in 2006 took place in September, and in 2007, September/October following heavier than usual rainfall throughout the summer.

On the Oak site significantly more movement was recorded along Stations 1 – 10 which initially seems odd as this line is oriented towards the North East. Less movement took place on the West facing line even though it had direct exposure to whatever sunshine there was.

Bottom left we reproduce the work of John Heuch when he radar imaged the Oak site. Are there more roots, or is the soil more shrinkable? Or does the tree have some physiological preference for this aspect?



The average of the readings over time for both trees has a general form as shown below. Despite variations in the geology, moisture uptake, species and climate differences between the two sites, the patterns are very similar. Ground movement near the Oak is shown as a red line, and near the Willow as a green line.



Different soils, different trees – but very similar signatures. These graphs help us to characterise ground movement and follow the work of Giles Biddle and the BRE.

The Clay Research Group

E.R.T. BULLETIN

Glenda Jones ~ Keele University

Laboratory Objectives

1. Investigate the electrical responses of clay (in terms of resistivity) and the volumetric changes experienced by London clay when it is dried.

2. Assess, cross-correlate and validate the Aldenham ERT monitoring data and

3. Provide clay resistivity ranges to be used within ERT forward modeling and inversion improvements.

In order to achieve these objectives experimental work conducted in the laboratory is being undertaken involving the controlled drying of several clay models. Laboratory methods employed include the SAR (Square Array Resistivity) method, gravimetric moisture content determination, temperature monitoring and linear shrinkage assessments.

The laboratory results reported here are from the Phase 1 - Preliminary model CM003/11.01.08, which is comprised of unsieved London Clay obtained by MatLab from Bishops Stortford, Essex (CM6 1SP), with the following index Properties; PL = 24, LL = 78, PI = 54.

Results in Figure 2 reveal a general exponential clay resistivity - moisture content relationship similar to that reported by Conein and Barker, 2002, McCarter, 1984 and Russell and Barker, 2004).

The results of which, show that when drying is initiated at a high clay moisture content (in this case 62% (w/w)) the change in resistivity is very small until the moisture loss exceeds a specific percentage.

In contrast to research previously published however, the results here take into account linear shrinkage changes and multi-directional changes in the resistivity (represented by the alpha and beta resistivity values).

The inclusion of this data reveals highly informative and valuable preliminary conclusions that not only further knowledge regarding the capabilities of electrical methods within the Tree-Induced Subsidence context but also for the direct assessment of our Aldenham monitoring data sets.

For example;

Although complete clay desiccation can cause resistivity values to increase up to a factor of 40 (from 8 - 310 Ω-m), the first 60% of shrinkage occurs within a very small resistivity range (<50 Ω-m).

Isolation of data from the first stages of drying (before the exponential trend) as shown with the inset example shows that there is a strong positive linear trend in the shrinkage-resistivity change relationship, which is useful for assessing the onset of desiccation.

The deviation in the two resistivity plots after 40% moisture loss, highlight a threshold potential for errors (noted by the increase in standard deviation ranges) and significantly variable resistivity data. Both of which may be attributed to the prominence of air in the clay matrix, shrinkage cracks and poor contact resistance.

Although the above are preliminary conclusions, information such as this can drastically refine the way we look at the Aldenham field data and assess shrinkage and SMD potentials.

Dry Day 0 Dry Day 17 Dry Day 36

Figure 1

Photos of the London Clay model CM003/11.01.08, throughout air drying.

The Clay Research Group

E.R.T. BULLETIN (cont…)

Glenda Jones ~ Keele University

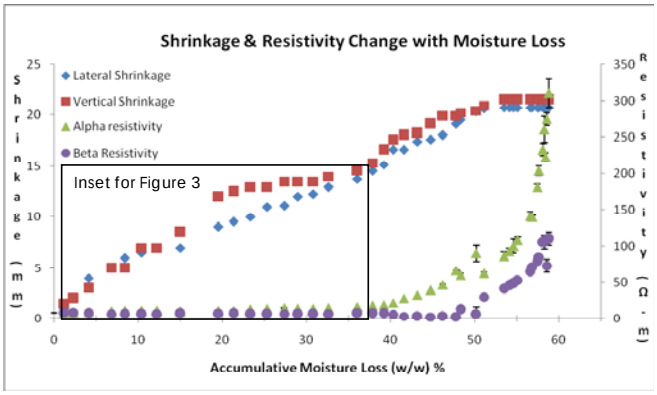


Figure 2
Preliminary Resistivity-Shrinkage-Clay Model Laboratory Results

Errors bars on the resistivity values represent +/- standard deviation ranges. The area contained by the rectangle is shown at an enlarged scale below.

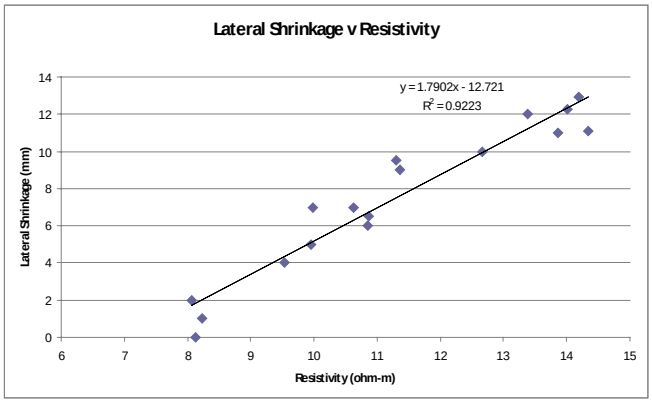


Figure 3
The resistivity-shrinkage relationship for the first 15mm of shrinkage.

The 80mm thick clay samples are contained in a Pyrex dish.

In order to support the above conclusions and assess the variance in data using differing London Clay compositions, a second phase of multiple clay laboratory work is underway and more details will follow.

Glenda Jones

ASTON UNIVERSITY
BIRMINGHAM

Domestic Subsidence & Trees
The Real Risk

12th June 2008

Contact

Anomalous Results

Below is a plot of some of the sites where anomalous results have been obtained when using the filter paper test – many in the Essex area, but not exclusively.

Andrew Ridley carried out investigations when he was at Imperial College around 1999 and suggested the erroneous output might be attributable to the soil mineralogy.

The anomalies now appear more often and over a wider area. MatLab's research suggests they might be attributable to inconsistencies in the Whatman's filter paper.

A robust test, offering repeatable and sensible results is needed. From our investigations at Aldenham, the oedometer is currently the preferred method whether using disturbed or undisturbed samples.

A test that directly measures suctions would be welcome.

MatLab continue their research into this area and we will be providing regular updates.

The Clay Research Group

POSSIBLE TREATMENT SITE

Richard Rollit and Stephen Briant of Crawford & Co., have suggested a possible site to trial the ground treatment, leaving the trees in place whilst hopefully restoring stability to a single storey rear extension that falls within the influencing zone of 2 No. 14m tall Ash trees, 10 – 12m away from the structure. See location and site plan right.

Below we have modelled (a) the likely Plasticity Index of the soil and (b) using LiDAR imagery estimated root zone of the trees.

Our disorder model suggests the roots of the Ash extend beneath the extension by about 3mtrs and the shrink swell potential is around 51%.

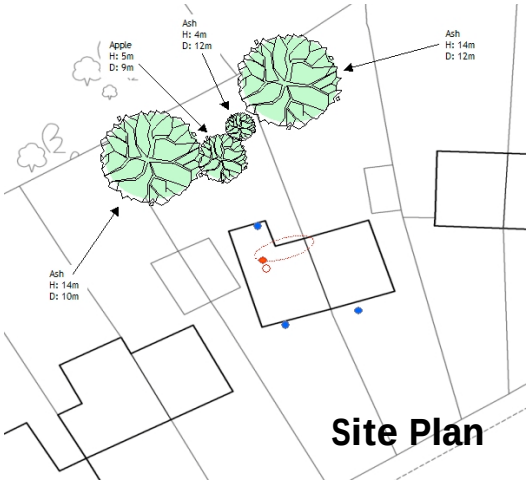
We are waiting for copies of the site investigation and arborists report to see how our estimates fare. Soil suctions are estimated to be around 400 – 500kPa in the summer.

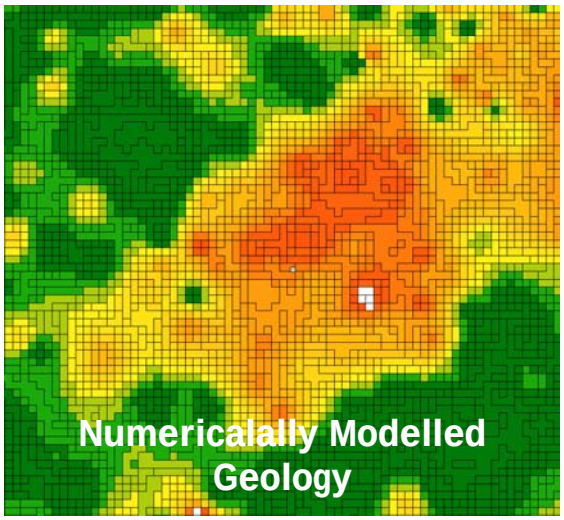
If we can obtain the approval of the homeowner and instucting insurer, we would hope to commence work shortly.

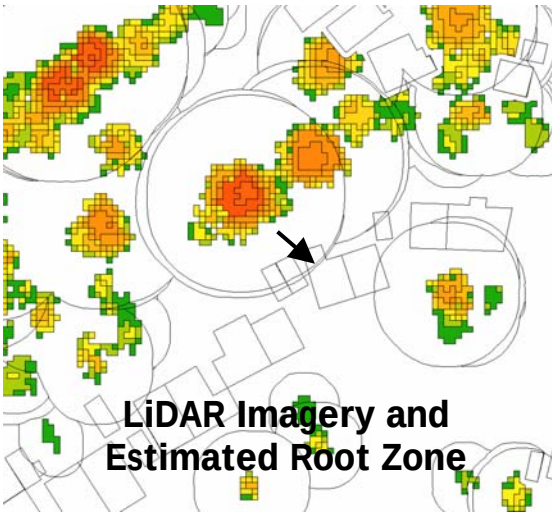
Traditionally an engineer would visit the site, instruct investigations and soils would be tested whilst an arborist was appointed. The costs of investigations might be in the region of £1,200, plus the engineers fee.

Numeric modelling provides an answer in under an hour – although a site inspection by an adjuster, surveyor or engineer is of course essential to 'set the scene', inspect and report on liability etc.

This apporach isn't suitable for every case but it offers great benefits in North London (for example) at times of surge.







The Clay Research Group

POSSIBLE TREATMENT SITE

Above, a vertical crack between the extension and the rear house wall. There is further damage internally. Below numerically modelled soil suctions for the summer month, assuming a normal year. Bottom, right, a screen-shot of the disorder model.

Left is a picture of the damaged extension (previous page) and below is a screen print from the Disorder Model which is iterating through seasonal movement to estimate both the extent and amplitude of ground movement.

Traditional investigations are a 'snapshot in time' whereas the disorder model is able to estimate ground movement throughout the season and do 'what if' modelling to see what would happen in a drier summer, or 'what happens in five years time if the tree is left in place' taking account of further growth.

For the present circumstances the estimate of ground movement is around 25mm, and as we saw on the previous page the model estimates ground movement resulting from root growth extends under the rear wall of the house as well as the extension.

The objective of the research is to settle claims quicker and without the disruption and expense of traditional methods, but only where safe to do so.

The only barrier to claim resolution is how the tree is dealt with and if we can move to a stage where they are retained in most cases, and repairs can be undertaken in the Spring following notification of damage, then we may have a solution but this does mean that the various parties will need to come together to (a) validate the model, (b) understand when it can be used safely and (c) agree the terms of its commercial application.

We welcome hearing from anyone with an interest, willing to submit actual cases for comparison with the modelled output. We would be aiming to develop a form of ABI Industry Agreement using agreed (and technically robust) criteria. Fewer trees would be lost, insurers and their agents could settle claims quicker and at less cost. The homeowner would hopefully retain the tree and suffer less disruption.