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

February 2011

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Seminars

Jon Heuch from Duramen Consulting has reported that the RIBA Urban Tree Knowledge Community and the Trees & Design Action Group will present a seminar on cost-benefit analysis of a new application, i-tree, which was developed in the USA. Trials are now underway in the UK.

Launch of the RIBA Urban Tree Knowledge Community and The Canopy

Thursday 17 February 2011,
8.30am - 1.00pm
(Registration from 8.00am)

NLA, The Building Centre,
26 Store Street, London WC1E 7BT

The i-tree web site tells us *"i-tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools."*

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ASTON UNIVERSITY

The annual conference will be held at Aston on Thursday, 12th May this year and we are asking for papers from the industry on topics associated with subsidence - soils, investigations, insurance, trees, risk management and so forth.

Please send to clayresearchgroup@gmail.com or to Dr Sadeghzadeh at Aston (cpd-seas@aston.ac.uk),

Study Area - Camden

This months study area is Camden. Like Islington and Southwark, Camden has a north south divide, with clay to the north, and alluvial soils to the southern section adjoining the Thames.

The study identifies the riskier areas of the Borough and reports on its tree population. Maps are provided of the geology, surface terrain, tree distribution and claims experience.

The Clay Research Group *News ….*

Hurricane Yasi

Michael Lawson from OCA has sent in this picture provided by BBC News showing the distribution of roots from trees upturned by the recent hurricanes in Australia.

Michael suggests that the unbalanced distribution of rooting is due to the presence of an amenity strip running alongside the tarmac roadway. Roots appear to have proliferated in the amenity strip and this is known as a 'plastic response' to environmental conditions, reflecting the ability of root systems to take advantage of available water and soil nutrients.

Transpiration Rates

Jon Heuch of Duramen Consulting has drawn our attention to a recent paper on transpiration rates. Quentin, et al have published a paper in Agricultural and Forest Meteorology, entitled *"Responses of Transpiration and Canopy Conductance to Partial Defoliation of Eucalyptus globulus trees",* Volume 151, Issue 3, 15 March 2011, Pages 356-364.

"Following the removal of the upper canopy layer, defoliated trees responded by exhibiting compensatory responses in transpiration rate and canopy conductance of the remaining foliage." The trees were 4 years old specimens but this has a bearing on the current project to assess water uptake following pruning.

The paper goes on to say that defoliated E. globulus showed significant improvement in plant water status.

RESEARCH DIARY

Transpiration Rates and Street Trees

Margaret MacQueen from OCA has arranged a follow-up meeting at Islington to discuss how we might jointly research moisture uptake of street trees following pruning/pollarding/crown thinning regimes.

This will be attended by Neil Hipps from East Malling Research, Margaret, a representative of the CRG and Jake Tibbetts, James Chambers and Patrick Richardson from Islington Council.

The project is currently being scoped and budgets produced. How should we measure moisture uptake and at what intervals do we take readings?

Birmingham University EKO Project

We have a meeting arranged in April to scope the work on electrokinesis working with Birmingham University and Foundation Piling. Jon Heuch has agreed to provide arboricultural advice. Industry attendees will include Richard Rollit and Jeremy Aitchinson from Crawford & Co., Allan Tew from InFront and Mike Duckworth from Cunningham Lindsey. We have joined with Birmingham to support a network response to ground problems and infrastructure generally.

Synthetic Tree

Our work on the synthetic tree has been defeated by the difficulties in building a model that would adequately replicate the outcome following the application of a range of treatments, although the basic model (i.e. measuring transpiration in the absence of soil treatment) holds good.

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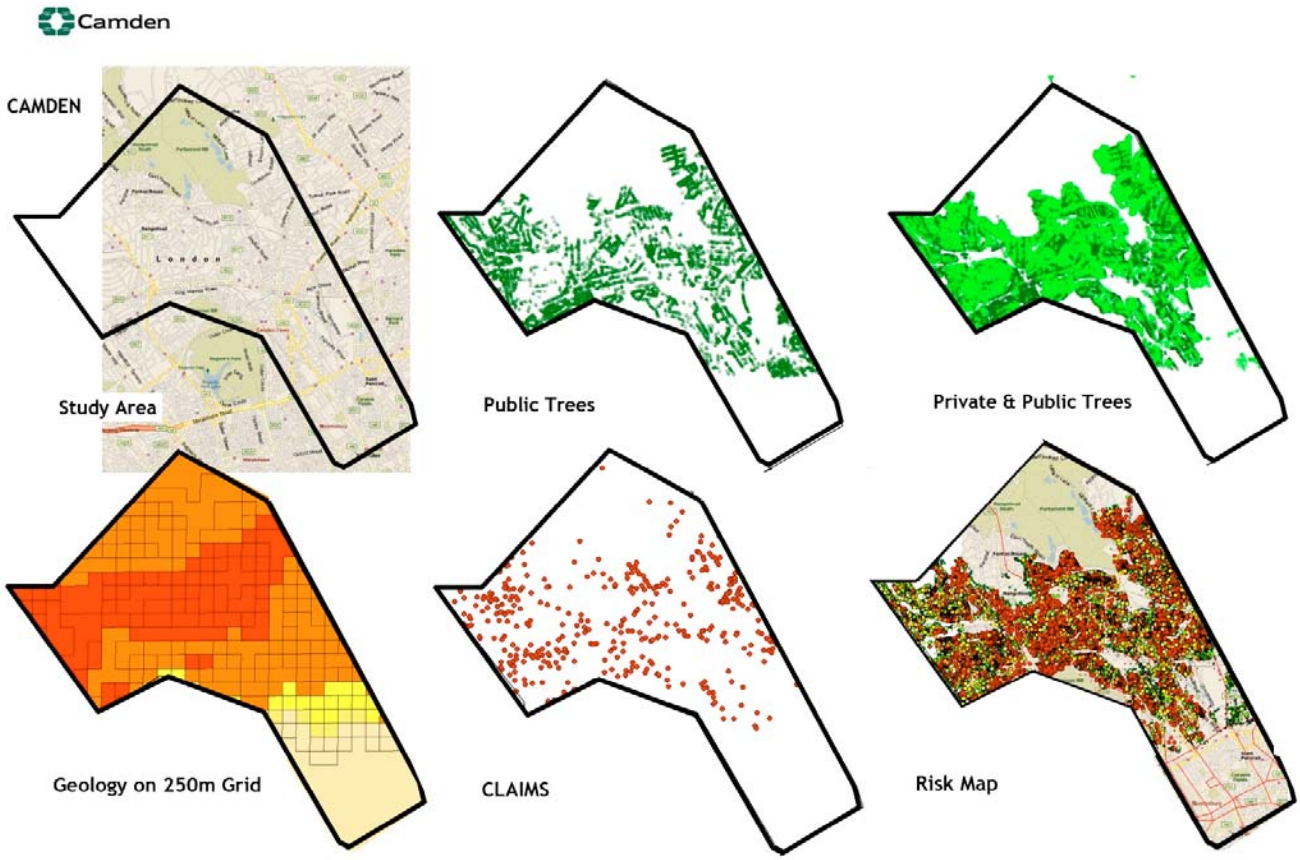
Camden Study



Camden occupies an area of around 22 sq. km and is bordered by Parliament Hill to the North, and Oxford Street to the south.

It has a high claims frequency and, like Islington and Southwark (previous study areas), has a north/south geological divide.

The claims map confirms very little risk from root induced clay shrinkage to the south, bordering the Thames, where the soils are alluvial deposits and gravels.

The geological map shows a band of highly shrinkable outcropping clay soils to the north of the borough, passing east to west.

The clay soils included in our sample have a maximum Plasticity Index of 58%, and a mean of 41%.

Trees have only been plotted where there are shrinkable soils to ensure that our analysis only includes trees that are likely to be involved with this class of claim.

For the same reason, parkland trees have been excluded.

There are around 7,700 trees that meet this criteria – i.e. street trees within influencing distance of a domestic property, situated on a clay soil.

The maximum tree height from this sample is around 30mtrs, and the average is 10mtrs.

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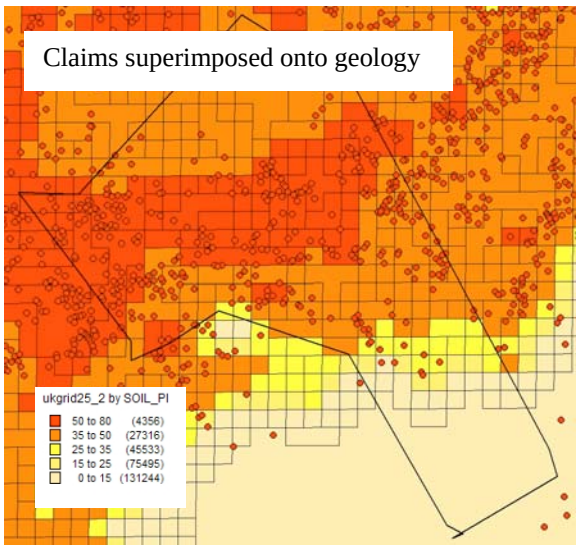

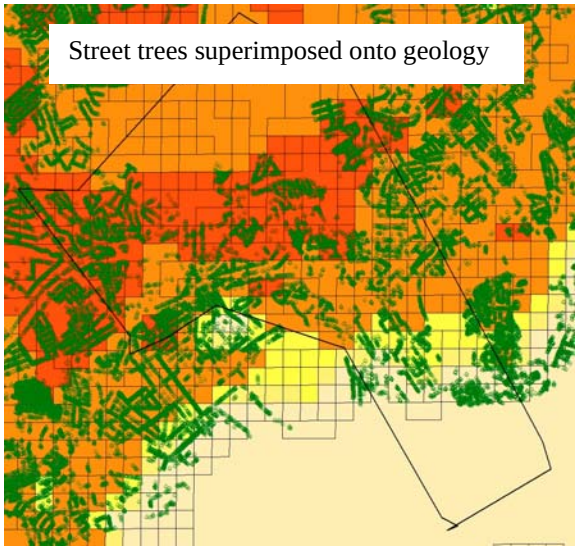

Higher frequencies of claims (red dots superimposed onto the geology grid) follow the clay belt, and the risk increases with tree concentrations, as can be seen from the above images. The frequency of claims compared with postcodes is 0.1189 on the highly shrinkable clay soils (red) and 0.0725 on the less shrinkable soils (orange). The suggestion being that the highly shrinkable soils present an increased risk of 1.5. From a visual inspection the risk is elevated (i.e. there is a greater density of claims) by the concentration of trees to the left of the highly shrinkable clay soils. Please note the frequencies do not relate to one years claims experience.

Left is an image of the notional 'root overlap zone', taken from the high risk section of Camden. Using our estimated root zone (i.e., the zone sufficient to cause building movement, rather than any attempt to model where the roots actually are) provides a different picture to the one we normally see, and allows us to combine both height and distance, whilst taking into account building vulnerability.

As suggested before, buildings most at risk might not be those where the entire building footprint has root encroachment. Rather it may be the buildings with less than 50%.

The map is based on OS mapping and LiDAR data flown in 2005.

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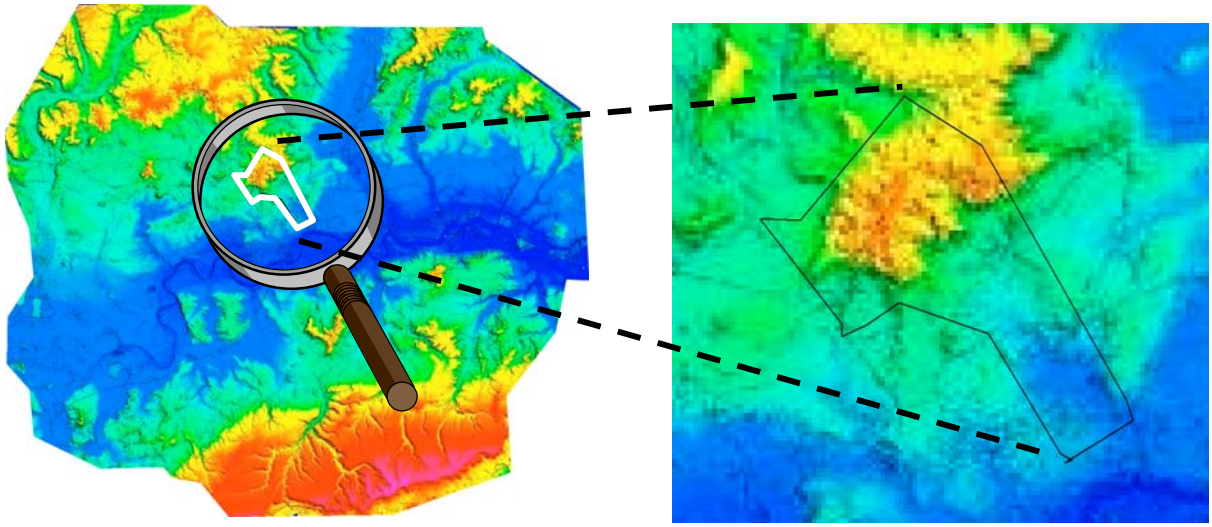
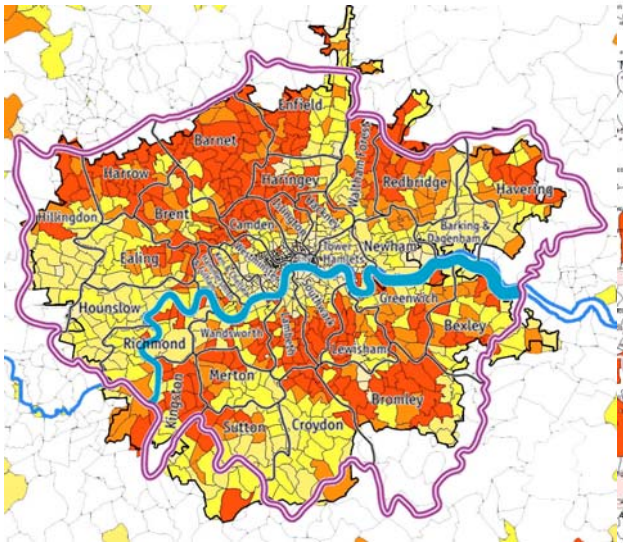
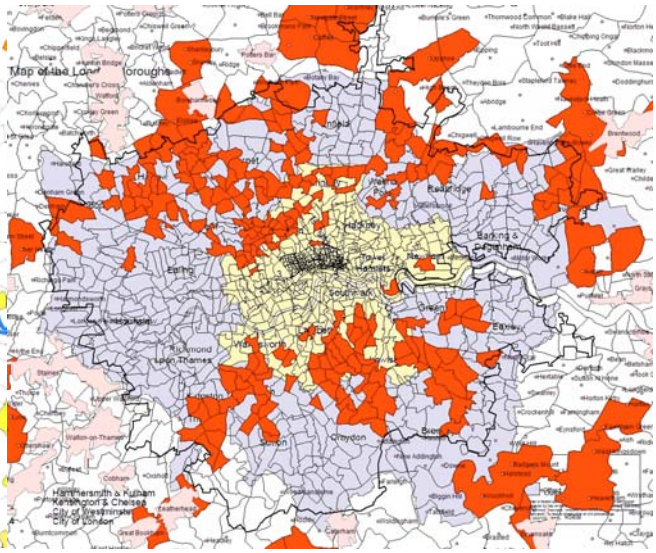


LiDAR Digital Terrain Model

Camden Terrain Model





Claims Frequency Map

Surge – Postcode Sector Map

The relationship between claims, surge, our geological map and the terrain model (stronger to the north of the Thames than the south) can be see in the above maps.

The terrain model reflects something of the depositional sequence, with gravels and alluvial soils (blue) lying in the clay basin adjoining the Thames and the drift deposits that form Parliament Hill to the north, yellow.

Claims follow the geological map, and surge years simply 'amplify the signal', by making busy sectors even busier.

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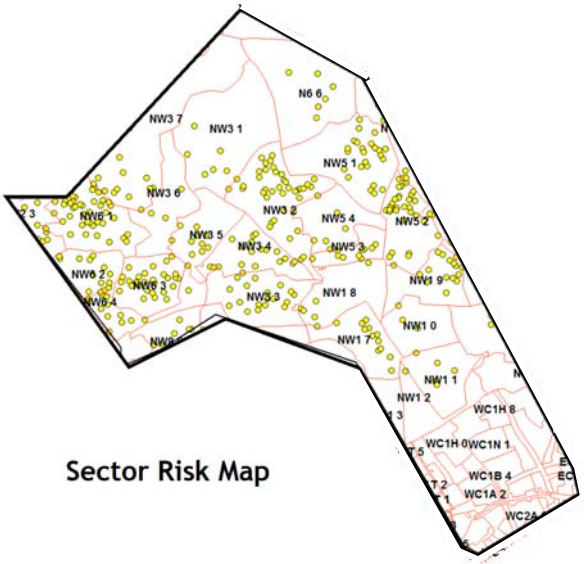
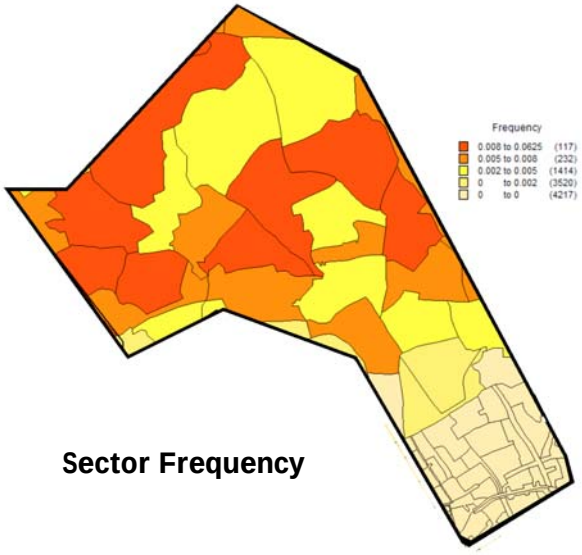


Sector Risk Map

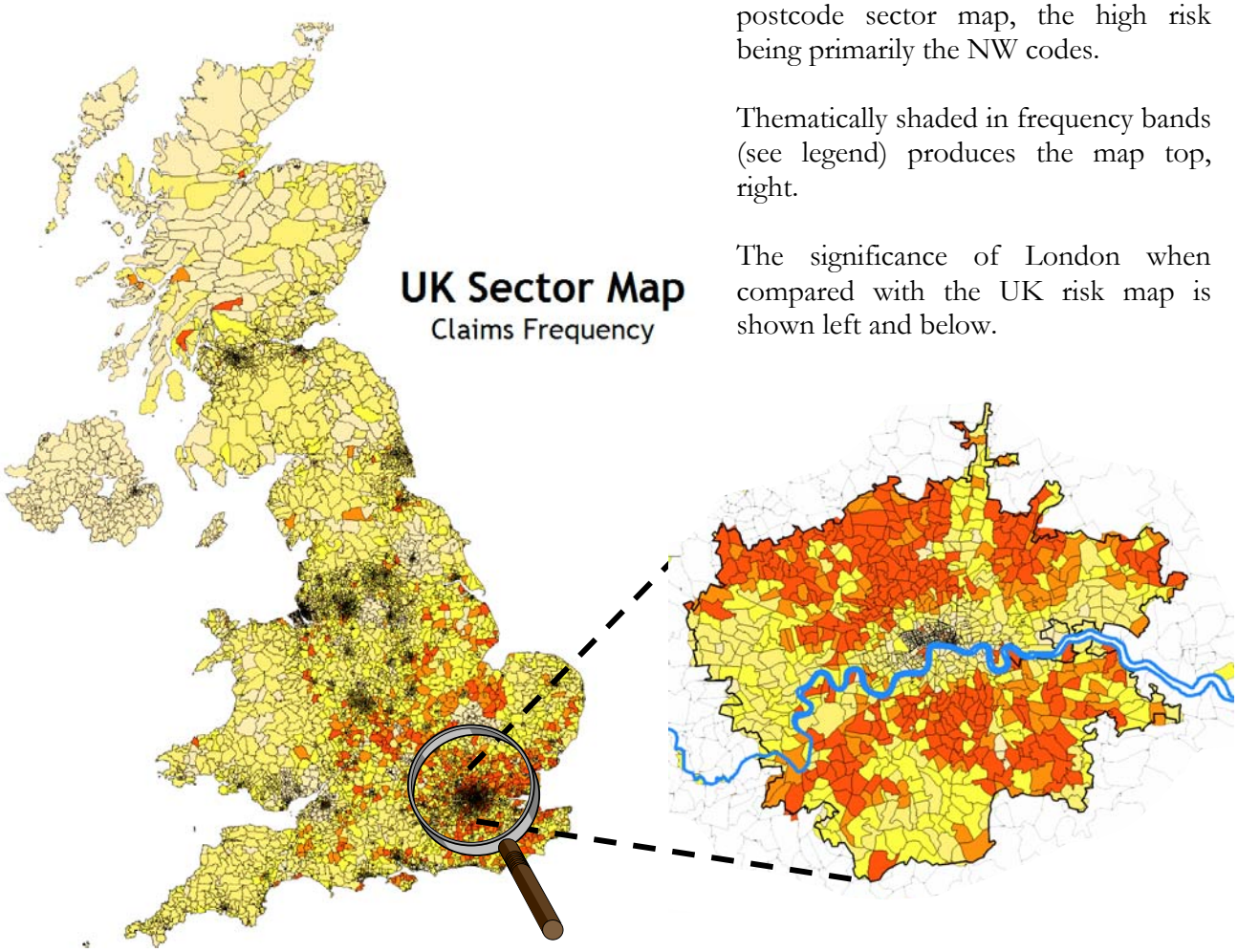


Sector Frequency

Individual claims are plotted on the postcode sector map, the high risk being primarily the NW codes.

Thematically shaded in frequency bands (see legend) produces the map top, right.

The significance of London when compared with the UK risk map is shown left and below.



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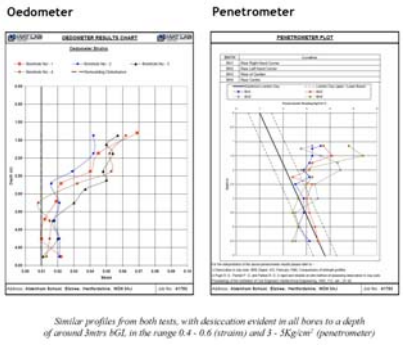
What have 5 Years of Research Delivered? Part 3.

A

B



Similar profiles from both tests, with desiccation evident in all bores to a depth of around 3mtrs bGL in the range 0.4 - 0.6 (strains) and 3 - 5Kg/cm² (penetrometer)

C

D

Modelling risk, taking account of climate, trees and soils, has been one of the more tangible outputs.

The risk model uses our unique map outlining the shrink/swell properties of the soil across the UK and superimposes claims data. Not only claims frequency, but also the most probable cause and the proportion of valid claims by sector.

LiDAR data (A) plots the location of trees and describes their canopies on a 1m grid all in relation to buildings, rendering a digital view of London.

All data has been presented in a GIS format (B) to clarify the geographic component by city. 'In the alternative' use of the shrink/swell maps reveal the risk from escape of water and other causes.

The outputs include a house-by-house risk map of London out to the M25, and a full postcode map of risk for the UK.

Site investigations have researched the use of disturbed and undisturbed sampling techniques, and a range of in-situ and laboratory tests.

Oedometer, suctions, moisture content and penetrometer readings have been compared with precise level data, and testing over time has produced an insight into the benefits and drawbacks of each approach.

Disturbed sampling often produces over-estimates of desiccation, and all tests perform better the dryer the soil. The penetrometer (C) appears to offer a cheap and reasonably reliable method of testing on site. The filter papers need to be carefully calibrated to obtain the best results using suctions. Oedometers (D) tend to produce good results using disturbed or undisturbed sampling, provided care is taken when consolidating the sample to the in-situ stress.

Validating the results of soil testing by using precise levels provides an obvious truth. Precise levels record actual ground movement reflecting tree physiology, climate and soil mineralogy as well as building vulnerability and many aspect of our research point to this conclusion. Precise levels are the preferred method of investigating subsidence claims.

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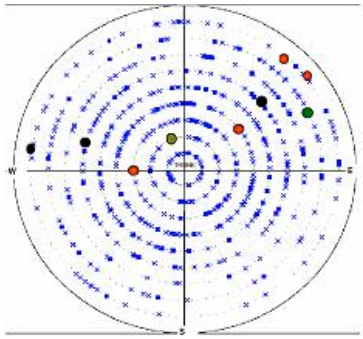
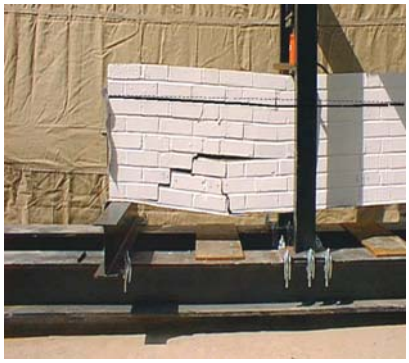


E

F



G

Imaging and monitoring tree-induced subsidence using electrical resistivity imaging

I

What have 5 Years of Research Delivered? Part 2.

Aldenham has provided a site for others to undertake work on their own account, sharing the output.

John Heuch of Duramen Consulting tested ground penetrating radar (E), tracing large roots from the Oak tree and plotting their depth.

Clive Bennett from MatLab has developed new soil test techniques (F) and is now working on a PhD to review this and other aspects of testing fine grained soils.

MatLab have also undertaken research on masonry flexure – how far can walls bend prior to cracks appearing (G), and what benefits are derived by post tensioning?

This work has been applied to a few claims, although there are practical drawbacks which would limit its application in domestic properties.

Allan Tew of the CRG is working towards a second PhD exploring alternative methods of repair. Masonry strengthening, ground treatment and so forth.

Glenda was awarded her PhD last year for her work on Electrical Resistivity Imaging and published a paper (I) describing her work at Aldenham.

This year Margaret MacQueen and the CRG have a joint paper accepted for delivery to the Urban Tree Research Conference in Birmingham entitled "Trees in the Urban Environment – Current Research Relating to Domestic Subsidence in the UK".

Birmingham University have appointed a PhD student to research electrokinesis to stabilise clay soils where there is root activity. This is part funded by Foundation Piling and has a broad industry interest involving all major adjusting practices.

The CRG are also involved with the current project to establish the outcome of pruning when compared to thinning on street trees, an extension of the Hortlink research undertaken by East Malling.