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

January 2011

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CONTENTS

Update

A meeting has been arranged towards the end of January, hosted by Geotechnical Consulting Group (GCG), to develop a research program to understand how thinning or reduction of street trees influences building movement.

Attendees will include Mike Crilly of GCG, Neil Curling from Halifax, Tim Freeman of GeoServ, Margaret McQueen from OCA, Neil Hipps, East Malling Research, Andrew Buckley from RSA, Keith Sacre from Barcham Trees plc and a representative of the CRG.

The background links the Queens Park study by the BRE for the period 1993 - 1999, and the Hortlink project by Neil Hipps and his team from East Malling Research .

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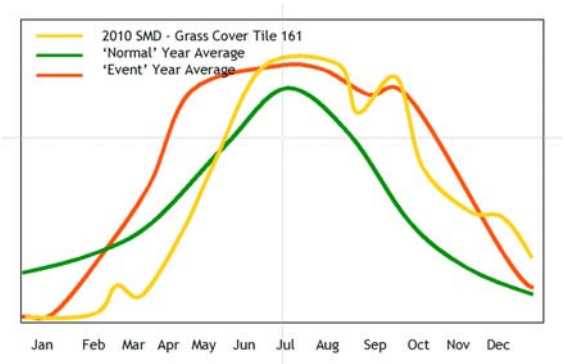
Proposed Changes to TPO Legislation

Our thanks to Kieron Hart of Marishal Thompsons for his paper outlining the proposed changes to the TPO legislation.

This is available for downloading from the CRG website.

Weather Watch

The Soil Moisture Deficit traces claim notifications in 2010. A late start, developing very quickly as we see from the steepness of the line and then peaking in July and August before the inevitable, if slow, decline.



SMD data has been supplied by the Meteorological Office for Tile 161, grass cover and Medium AWAC.

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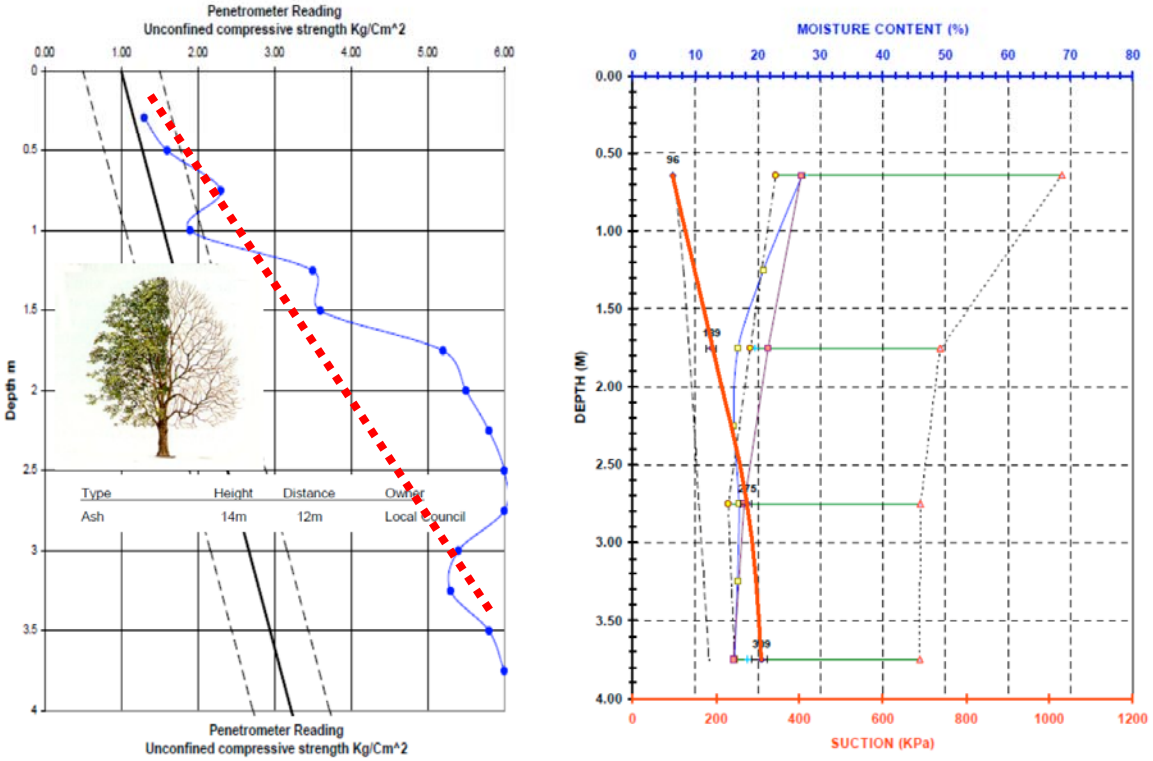
"Memory of Desiccation"



Postcode AL - PI 35 - 40% - November 2010

The potential to detect desiccation later in the year – in this case November - is revealed above. Although rainfall has all but dissipated the negative porewater pressures, the penetrometer reveals high shear stresses following the characteristic profile for tree root activity.

A residual deficit, coincident with this bulge, is revealed by both moisture content and suctions at around 2.5mtrs below ground.

In this case the tree is a 14m high Ash tree located 12m from the property. The 'equilibrium' line has been plotted as a broken red line on the penetrometer graph.

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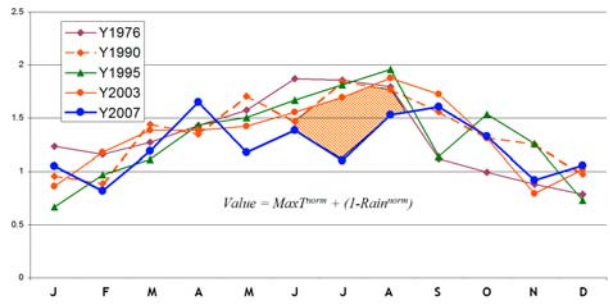
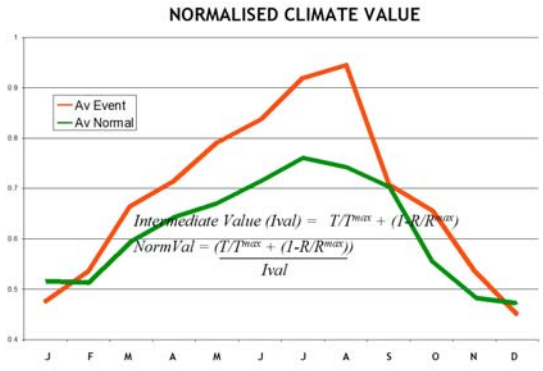
Critical Period

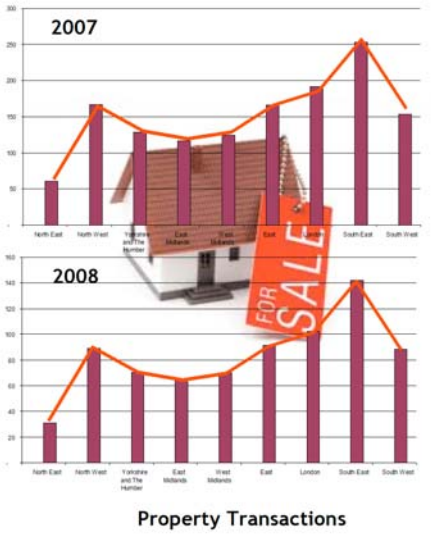
Below are the temperature and rainfall data from the Heathrow weather station on a normalised scale – that is to say, instead of recording the data as degrees C, or 'mm of rainfall', we have taken the maximum value over the last 50 years, and plotted them onto a scale 0 – 1.



The importance of the summer months is immediately evident if the rainfall value is subtracted from the temperature. Using this approach it can be seen that although the temperature in April was high and rainfall low, 2007 was a normal year looking at the summer months.

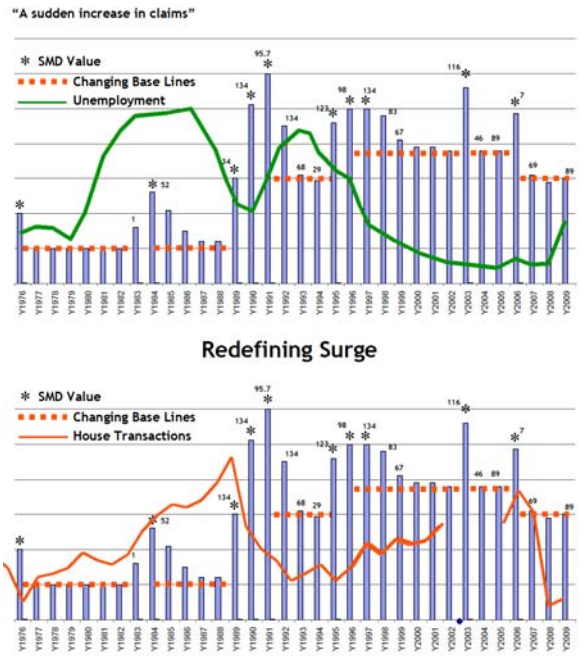


The method is shown above. Taking the value of both elements and then 're-normalising' allows us to see the relationship and understand the difference between a normal and an event year.



The influence of house sales on claims, by region, can be seen above. Surveyors pre-purchase reports often trigger claims, and the South East is the busiest area.

Below we have plotted claim numbers and surge years against unemployment (top graph, green line) and house sales (bottom graph, red line). As far as we can see, there is no obvious correlation.



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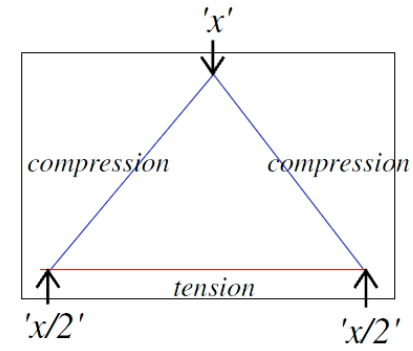
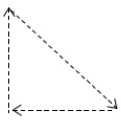
MASONRY FLEXURE

Several years ago MatLab researched the effect of post-tensioning on masonry panels. They induced flexure using the arrangement shown below, imposing a point load at the centre of a 2.2m long panel supported at either end and with temporary propping along its length.

The panel was acting as a shallow truss with masonry in compression and the lower section of the panel in tension, as below.



Modelling the panel as a simple truss to derive the force diagram (shown right), and an idea of the tension in the bottom cord to be resisted by the post tensioned rod.



With no post-tensioning, the lower section of the panel cracked with a loading of 23.8kN. After post-tensioning with a force of 40kN applied to the bottom cord, the panel supported a load of 89.4kN, resisting a Bending Moment of 50kNm.

A variety of panels were built, and a range of materials used. Above we have one of the corner panels in engineering brickwork.

Below, the method was applied to a long gable wall built off a deep footing on the Mercia Mudstone with a P.I. of around 25%.

The treatment resolved the (minor) problem of root induced clay shrinkage as far as we are aware and the gauge reveals crack closure on tensioning.

A possible use assuming the problem of openings and H&S issues can be overcome might be low level damage of an irritating nature where the tree cannot be removed and recurrent cracking is likely.

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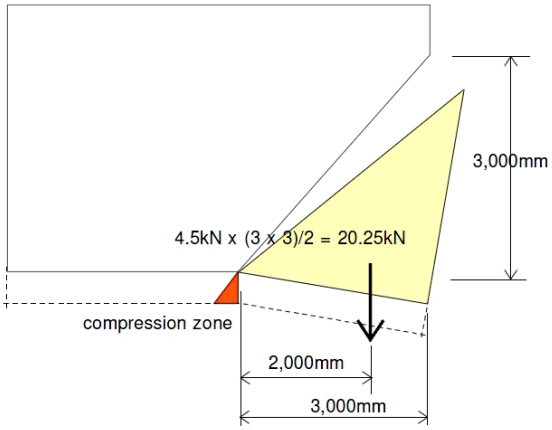
Post Tensioning

How and when would this be applied? Primarily for low level damage and following winter recovery – i.e., sometime around April/May.

Using the BM and applying it to a corner location, the figures would look something like this.

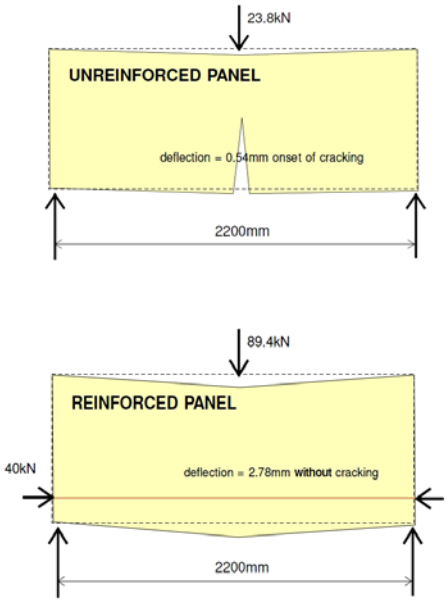


BM generated by rotation of brick panel = 20.25kN x 2mtrs = say 40kNm. We can see from previous example using test panel, the post tensioning system can sustain BM > 50kNm, therefore use 15mm high tensile rod, tensioned to 40kN.
Check compression in masonry below the reinforcement.
Force to be resisted = 40kNm/lever arm (assuming 600mm of masonry below the level of the rod, and triangulated forces in masonry), then
*F = 40*10^6/400 = 100,000N.*
Compression in masonry = 100,000/(220x600) = 0.77N x 2 (due to stress block) = 1.5N/mm2.

Unfortunately the research was cut short and we have no idea of the effect of long term strains but post-tensioning is a well documented topic in other fields.

There are problems in the application for domestic repairs because of the building layout. Sufficient masonry is required in the footing to cater for the lever arm and compression block and door openings often occur where we might want to position the rods. Slenderness is also a significant issue.

In addition, some form of warning would be needed to avoid the post-tensioned cable being cut through at some future date.

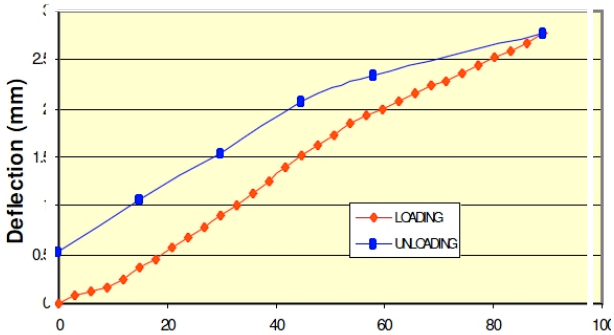


BM = PL/4 = (89.4x2.2)/4 = say 50kNm

The post-tensioned panel deflected nearly 3mm without any visible signs of cracking.

The graph below plots the loading-unloading line, with a plastic deflection on load removal of just over 0.5mm.

Loading-Unloading Plot



Applied Loading

The problem with 'normal' reinforcement is the fact that resistance to tension isn't mobilised until flexure is induced, and sometimes this means after cracks have developed.

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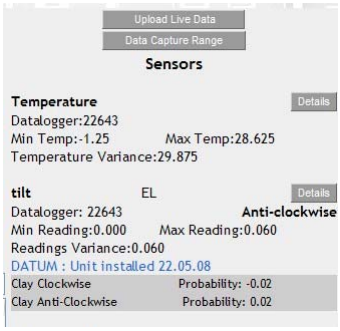
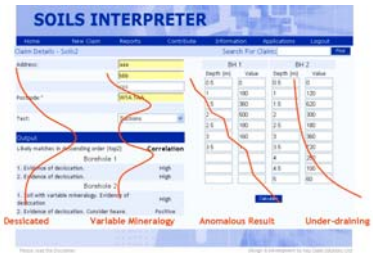
What have 5 Years of Research Delivered? Part 2.

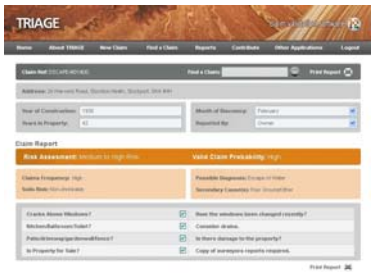
A



B



C



D

Telemetry – remote measuring using mobile telephony and the web – has been in use on high value projects for many years - Railtrack, The Mansion House, Heathrow Terminal 5 and of course, the Leaning Tower of Pisa.

The work of the CRG has been directed towards delivering an economic solution for predominantly low value, high volume domestic subsidence claims.

Measuring change every hour of every day using electrolevels, moisture meters and temperature sensors and sending data from site to our desk has the potential to deliver huge cost savings as well as being environmentally friendly in terms of CO_2 emissions.

Using systems to interrogate that data, issue reports and updates and determine when sufficient data has been collected to diagnose causation delivers maximum efficiency. Pattern matching software has been used (A and B) to interpret sometimes irregular and often interrupted data by comparing the output with a series of characteristic templates describing subsidence, heave, stability etc.

The software automatically logged on to the sensor at predetermined intervals and delivered a probability of causation taking into account seasonal fluctuations and soil type.

The application was able to produce a report, all automated, ready for checking by the engineer.

Other software makes use of this approach. The Soil Interpreter (C) interrogates the results of soil tests including suctions and strains. It was also programmed to detect soils of variable mineralogy, under-draining and provide an alert when potentially anomalous results were encountered.

Triage (D) used postcode matching and probability theory to derive the likelihood of a claim being valid for any location in the UK, and the likely cause. To do this it refers to a unique database of past claims experience and soils data, taking into account the date of notification and climate.

The application also accounts for operator behaviour, learning from its experience and adjusting the output accordingly.

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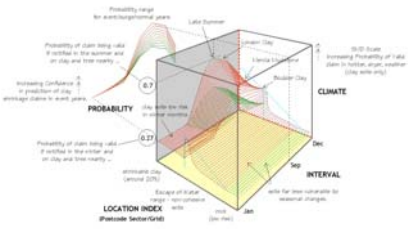
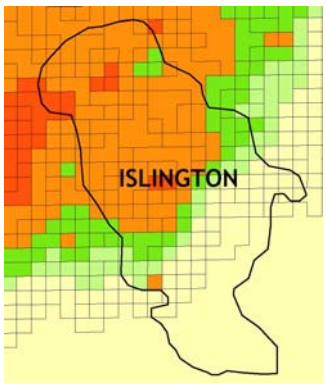
E

F



G VALID CLAIM PROBABILITY CUBE



I

What have 5 Years of Research Delivered? Part 2.

OSCAR produces an arboricultural and geotechnical assessment prior to the visit by referring to various datasets, allowing the user to amend them 'on line' following the site visit.

Combining season with soil type and vegetation refines the output still further and the application is used by several insurers to determine risk for underwriting purposes.

Insurers find the ProRisk (F) application useful. It delivers raw data for individual addresses and they can add other perils – flood or theft for example.

All of these applications refer to unique datasets, using correlation techniques and probability cubes to deliver their output. Using *a piori* values from normalised datasets every postcode in the UK has values ascribed for soil type, claims experience, ratio of valid/repudiated etc., and supplemented with tree data from the LiDAR survey within the M25 – the area of highest claim concentrations.

Climate data adds dynamic information.

The data has allowed us to produced occasional studies of some London Boroughs. How does one compare with another, and can we understand the underlying reasons for any variance?

The example, bottom left, illustrates the variation in risk between North and South Islington by taking account all of the elements, and expressing the output as frequency, all plotted on a 250m tiled grid.

Joint projects, with data provided by colleagues in the industry, has delivered useful information on risk. The Sidcup Road Project benefited from contributions from nearly all of the major practices. Individual claims were plotted to understand risk over time for a street populated by similar age properties and trees of similar species, age, height and distance.

Other studies have shown the chaotic nature of claims spatial occurrence and at the same time, their regularity in terms of frequency. It has also added a timeline with patterns emerging over ten years or so that are absent in any one year.