

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



June/July 2008

The Clay Research Group

“Dear Diary ...”

We are pleased to have been awarded a grant for our work under the Index scheme, which recognises it's value via sponsorship by ESRC, EPSRC, the EU Development Fund and Advantage West Midlands.



The funding will contribute towards our work on numeric modelling of moisture movement in fine-grained soils in the presence of tree roots. An extension of the Disorder Model.

It seems likely that our partners will be Keele University who are already actively engaged with The Clay Research Group at Aldenham and elsewhere.



Three years into the research and we are proud to have delivered so much in a relatively short period of time. Amongst the successes we can count (a) an improved understanding of how mature trees take moisture from fine grained soils, (b) the depth from which moisture is abstracted, (c) reporting the mechanism of stomatal control, (d) understanding how important moisture uptake at the beginning of the year is to subsequent tree behaviour, (e) the introduction of telemetry for a wide range of sensors, (f) validation of electrolevels and TDR (ground moisture) sensors, (g) numeric modelling for a variety of situations, (h) comparing different methods of testing soils (i) reporting on the new bentonite suction test being developed by MatLab.

Our thanks to associates including Keele University, Aldenham School, MatLab, Southampton University, GeoServ, and sponsors from the industry plus the various contributors.



Looking at past agenda's over the last 10 years of the annual subsidence conference in Birmingham we see a record of the changes in our industry.

In 1998 speakers were talking about underpinning, piling and monitoring buildings with Avonguard tell tales. They spoke about causes of movement on a case-by-case basis, but with very little national data available. At that time we might have been underpinning say 50% of valid claims. Now it is probably closer to 5%. The benefit of sharing data.

A few years ago Richard Driscoll chaired the seminar and raised the need to gather good data, and for it to be made available to practitioners. Robert Sharpe discussed climate change in 2004 and Giles Biddle spoke about trees and the difficulty they present when modelling risk.

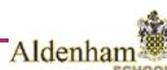
Two years ago Hilary Skinner represented the BRE and supported the move by the CRG to carry out research and look at soil testing and intervention techniques. Applications like OSCAR and VISCAT were demonstrated and we saw how some practices were adopting virtual investigations and soil modelling with great benefit.

Last year we heard about telemetry - gathering data from remote monitoring devices via the web and risk modelling using some advanced mapping techniques and LiDAR imagery.

We don't always notice change, but it is taking place and the Aston agenda reflects them, providing a snapshot of our industry over time.



The Clay Research Group were allocated a two hour slot to present their current work on intervention techniques at The Post conference. Most of the major names were present including Infront Innovation, Crawford & Co, Cunningham Lindsley, Marishalls, Giles Biddle, OCA, GAB and The Subsidence Forum.



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Modelling of Climate Impacts on Soil Moisture Deficit (SMD)

Derek Clarke and Joel Smethurst



We have measured soil water changes in a London Clay grassed slope and under mature trees for several years to investigate the seasonal changes in soil water content.

The differences between hot dry summers (2003) and cool damp summers (2007) is very much evident in the soil moisture and pore water pressure data.

The soil moisture changes in the grassed slopes can be explained using a water balance model which calculates the soil moisture deficit from climate data, and using physical properties of the vegetation and soil.

The model has been run forward to the year 2100 using synthetic climate data sets based on the UK Climate Impact Programme for a range of CO₂ emission scenarios. The predictions for change in the climate are warmer, drier, summers and slightly wetter winters. This model has been applied for a number of UK locations where shrink swell clays exist. The year on year climate change effects will be difficult to detect but cumulative effects will be come apparent as winter rainfalls fail to re-wet the soil profiles and as the relative frequency of extreme events changes.

The simulations showed that temporal changes in rainfall and warmer summers will cause the maximum soil moisture deficit at the end of the summer to increase by about 40 mm, which will cause a larger seasonal cycle of soil moisture wetting and drying. Larger cycles of soil moisture are likely to cause larger shrink and swell displacements, which will impact a range of infrastructures build on or of volume sensitive clay soils.

The relative impact of these changes is illustrated in Figure 1 which shows a frequency analysis of historical (1961-2005) and future (2010-2100) soil moisture deficits. Two exceptionally dry years (1995 and 2003) were chosen. In these summers, drying caused significant impacts such as differential displacement of railway tracks and building subsidence.

In 1995 the maximum soil moisture deficit was 172 mm which equates to a 1 in 45 year event (2.2% probability) and the 2003 deficit of 155 mm was calculated as a 1 in 10 year event (10% probability).

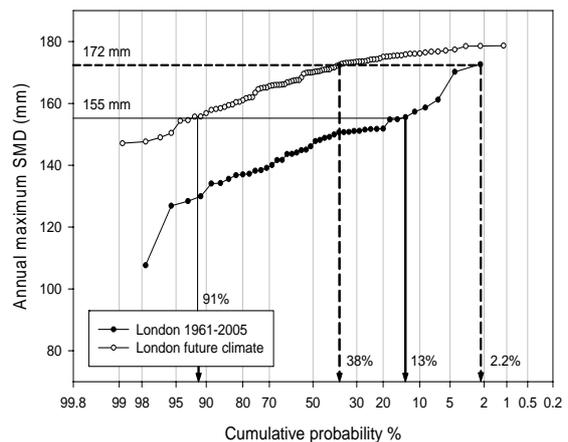


Figure 1.

Expected changes in frequency of maximum summer soil moisture deficit for London (Heathrow), 1961-90 and 2100-2090, for grass/shrub cover, and medium-high emissions scenario.

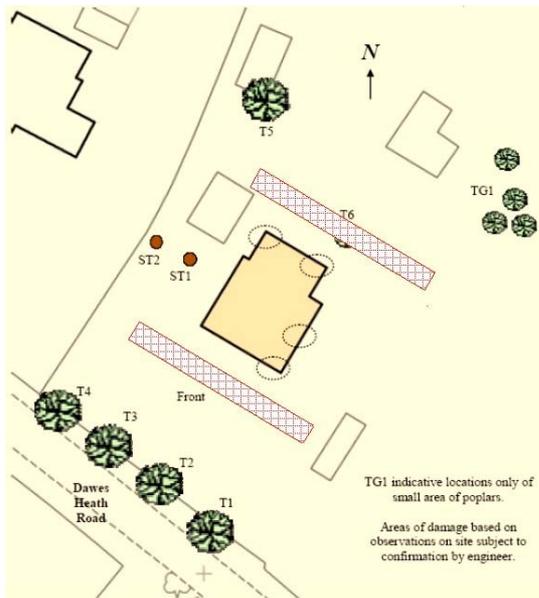
When these values are mapped on to the expected pattern of maximum deficits in the 21st century the probabilities change from 2% to 38% and 10% to 90% respectively.

This means that if the expected changes in climate do occur then what is at present a 1 in 33 year dry summer in London is likely to become the average summer and a moderately dry summer (currently a 1 in 10 year event) is likely to occur 9 years out of 10.

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Intervention Technique

Allan Tew from InFront Innovation has provided the second case study for the proposed intervention/ground treatment research project.



This was the property that formed the Case Study in last months edition. Damage appears to be due to a combination of influences. There is lateral movement at low level resulting from a 'swelling dumping' beneath a new trench filled foundation combined with ongoing seasonal movement related to the presence of a row of 12 - 15m tall Ash trees growing a similar distance away from the building.

As we mentioned before, the soils have a Plasticity Index of around 48% and the homeowners would like to keep the trees.

InFront have agreed to carry the risk and we have designed two treatment zones shown by the red hatched areas on the site plan, above.

The building will be monitored using electrolevels to detect change quickly and matters are made all the more relevant by an impending birth - hence the need for a prompt resolution!

The solution will be fast and cheap compared with the cost of investigations, monitoring and repairs.

The average treatment takes about two days to complete. Subject to the trials being successful it will offer a 'see and fix' solution.



Lightweight Plant



Injections



Augering the Ground



Treatment

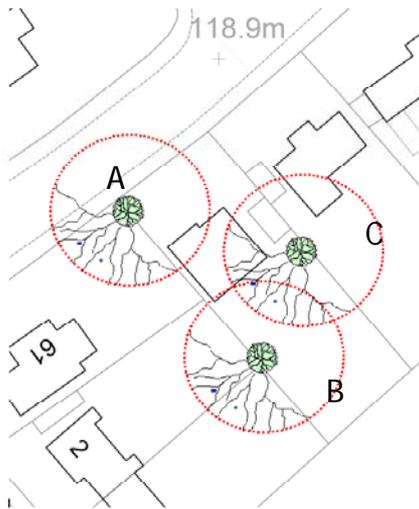
The mechanical auger drills a series of shallow holes very quickly for the 'treatment' to be applied using natural materials and the trench is back-filled using the excavated material.

It isn't a root barrier - we aim to deliver a 'soft' solution. It will be aimed at trees causing damage at the root periphery initially.

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Treatment Zones

It is anticipated that the intervention technique will be most effective for tree:house ratios of 0.8 and upwards. In the figure below, trees A and B are more likely to be manageable than perhaps tree C.



Foundation Depths

From claim records below we record the average depth of foundations where valid claims have been identified.



There is a link between shallow foundations and subsidence as we might expect, even when taking into account frequency - see earlier edition relating to number of houses in relation to period of build and claims.

Soil Testing Techniques

Our review paper entitled "Site Investigation and Soil Testing" issued in November 2007 described the results of various soil tests undertaken at the Aldenham site in 2006 and 2007.

Below is a simplified table of the output.

Undisturbed Oedometer ★★★★★

The test we are using as a standard against which others are assessed. The test produces very little drift (increasing strains) at depth. Outlines are 'sensible' matching expectations in terms of increasing strains in the anticipated zone of root activity, and near-zero values elsewhere. The test delivers consistent results matching the movement we have recorded using precise levels.

Disturbed Oedometer ★★★★★☆

Values very similar to those delivered by the undisturbed samples. Little drift at depth and strains coincident with root activity. Qualitatively and quantitatively the closest to the U100 oedometer results.

Filter Paper Test ★★★★★

Can produce irregular values, some increasing with depth and clearly anomalous. Careful consideration needs to be given to the position of the Ko line. High suctions at depth often accompanied by moistures that show no deficit may suggest very high suctions, when in fact there are none.

Moistures ★★★★★

Moisture content determinations and methods that seek to interpret them (Driscoll's technique, Liquidity Index etc.) are best used as an adjunct to other, more rigorous tests but are not in themselves sensitive enough to be used on their own.

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An excellent range of speakers presented their views at Aston this year.

Peter Osborne was the keynote speaker, and started the day by outlining how he thought 2003 was a turning point (for the worse) in the relationship between the Local Authority arborists and adjusters.

It became routine for adjusters to ask for trees to be felled, even though there was a feeling amongst Council arborists that pruning was effective. This put a strain on resources and in any event said Peter, was the law of nuisance really appropriate in cases of tree root trespass, where the roots couldn't be seen? How can it be based on foreseeability when nobody can say which tree will cause what damage, when?

Peter's introduction set the day for some lively exchanges as it seemed to fly in the face of the generally accepted legal position.

E-mail Peter on treesubs@hotmail.com

Glenda Jones from Keele University outlined her work on the sub-surface measurement of moisture change using ERT. Glenda has just completed her second year report and offers us an interesting insight into how tree roots abstract water.

E-mail g.m.jones@epsam.keele.ac.uk

Richard Rollit from Crawford & Co., acted as the chairperson and also delivered a talk on how we might model ground movement based on his experience using an application called VISCAT in a large adjusting office handling several thousand claims a year.

E-mail richard.rollit@crowco.co.uk

Jennifer Walsby from the British Geological Survey spoke about the geological risk maps in relation to a range of perils, including clay shrinkage, solution features, landslip, flood and so forth.

E-mail jcw@bgs.ac.uk

Paul Thompson of Marishal Thompson outlined his view of the proposed Joint Mitigation Protocol, which was a little different from the that provided by Peter Osborne, setting the scene for some interesting exchanges.

Marishal's revealed their work on root barriers and provided slides showing fairly deep excavations separating trees from damaged buildings.

E-mail paul.thompson@marishalthompson.co.uk

Tony Greenfield from Plexus Law delivered an update on the current legal position, citing Raphael v Brent [2008] amongst others. Here the courts held that 'reasonable probability' was sufficient grounds to recover even in the absence of soils data, investigations, root ID and so forth.

E-mail tony.greenfield@cogentclaims.co.uk

The message we took away was that Council arborists felt that adjusters and engineers were not very good at communicating and their letters tended to be threatening rather than accommodating. Adjusters (it seemed) wanted to fell trees, and didn't always offer the best evidence.

In contrast, Tree Officers are engaged to protect and retain trees wherever possible.

As a result, the LTO were fighting back using 'Chainsaw Massacre' headlines. The way the law is interpreted doesn't suit them, so they have applied a degree of spin to achieve their aims and hope to introduce change which may, if successful, lead to insurers paying for underpinning without the prospect of recovering their outlay, leaving the tree in place.

This led to an interesting debate but emphasised the need for (a) some good science and (b) improved dialogue.

