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

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www.theclayresearchgroup.org

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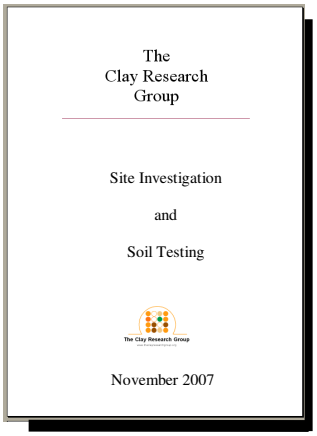
The second in a series of research papers outlining our findings at Aldenham is on the CRG web site. It deals with the investigations and soil tests that were carried out in May 2006 and June 2007. The results from various forms of testing are considered, using both disturbed and undisturbed samples.



Each test is assessed, together with the methods of interpretation. We hope the findings will be interesting to pracitioners. Some commonly encountered problems are included in the Appendix.

"Dear …..

Giles Biddle has raised some interesting queries relating to the Investigation paper and we have received comment from the geotechnical community offering constructive suggestions.

The CRG presented their findings to a meeting of the Special Interest Group of CILA at Aston in November and present to The Subsidence Forum on the 4th December at the BRE in Watford.

Clive Bennett of MatLab hopes to do an external postgraduate degree based on work he is currently involved with in refining the suction test. See the last page for some background.

September and October have the lowest recorded rainfall for many years apparently. Something of a record apparently.

This Edition

Lots of changes in the subsidence community.

Gary Strong has already left GAB Robins to take up his new role with the RICS and we wish him well. Gary takes up his new post in December.

Nigel Barham takes his place, leaving Cunningham Lindsey after many years of service. Geoff Ball moves up to take a seat on the board at CL.

Tony Boobier has also moved on and is looking at strategy with Pitney Bowes. Tony is involved with 'location intelligence' solutions, including risk, and is responsible for Europe and the EMEA territories.

At InFront Innovation, Paul Irvin is taking over control of the subsidence product. Paul is an exceptionally capable Chief Operating Officer and steers the ship forward after their success in winning the R&SA contract, sharing new instructions with Crawford & Co.

Shaun Pereira leaves his post at AXA after accepting a position as a Technical Claims Manager with another insurer.

Enough for anyone we would have thought, but there is a suggestion of still more to come.

Climate Change and Southampton

Trees are coming into leaf earlier and stay in leaf longer according to research published by Southampton University. They suggest we may have to be more selective when considering which species to plant to deal with these changes. The cause is rising levels of CO_2 rather than increases in temperature, and they report a delay in leaf drop of between 1.3 and 1.8 days per decade, accompanying a 13.5% increase in CO_2.

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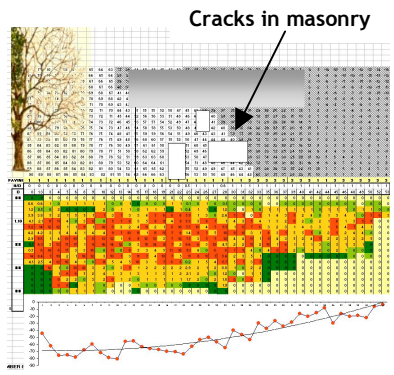
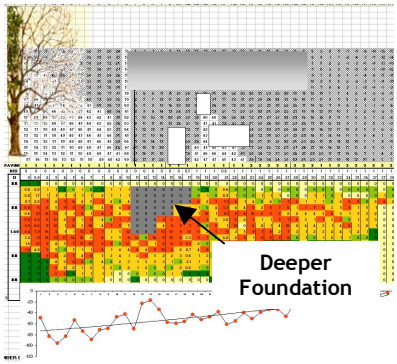
Disorder at the CILA Conference

The day was a great success for CILA with excellent attendance and high visitor approval ratings. During the course of the CRG presentation, Tom Griffiths of RTG Expert Technical Services wondered how the Disorder Model coped with underpinning, basements and cellars etc.

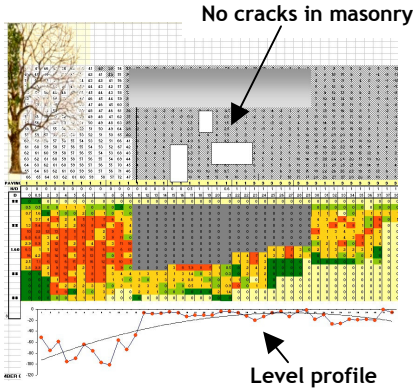
Below we hopefully illustrate the answer. By dragging and dropping we can very quickly describe foundation depths (grey cells), ascribing them a zero value in terms of swell potential.



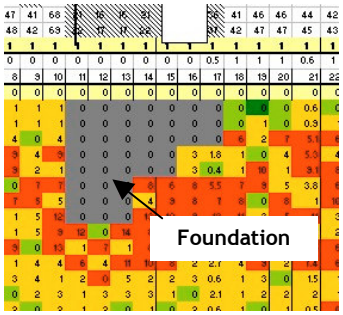
Ground Movement Shallow Foundation



Front House Wall Underpinned



Length of Gable Underpinned



Using the levelling profile (bottom section of above illustrations) we can see how much movement takes place at ground level due to the presence of the tree, and then model 'what if' scenario's. In the middle illustration we have deepened the front house wall (noted by grey cells), and right, underpinned the entire property, reducing the depth as we move away from the tree.

The latter produces a flat, level profile = stability. Left is an enlarged image of the greyed out cells, showing how we take account of deepened foundations by setting the values to zero.

The zone of potential crack propogation reveals the benefit – that is, the absence of tensile stresses – in the wall with a deeper foundation.

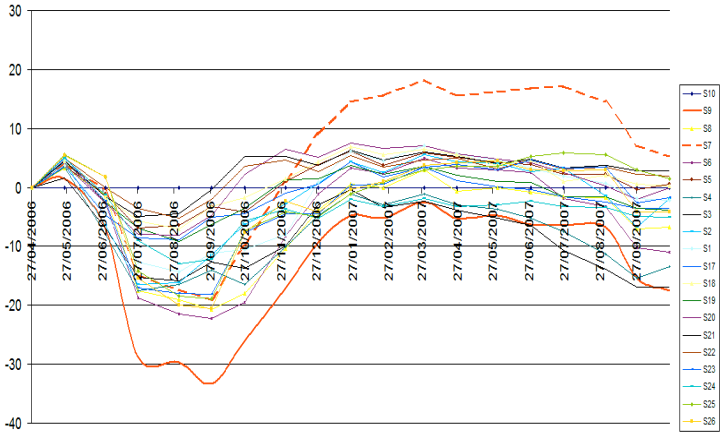
Precise Levels
- Aldenham Oak Tree -

Movement in the vicinity of the Aldenham Oak, shown right, commencing in April 2006 right up to 25th October, 2007.

Recovery at nearly all stations, with the ground rising above the comparable month last year.

Movement generally of a lower amplitude in 2007, reflecting the wetter weather.

Data for the Willow appears elsewhere.



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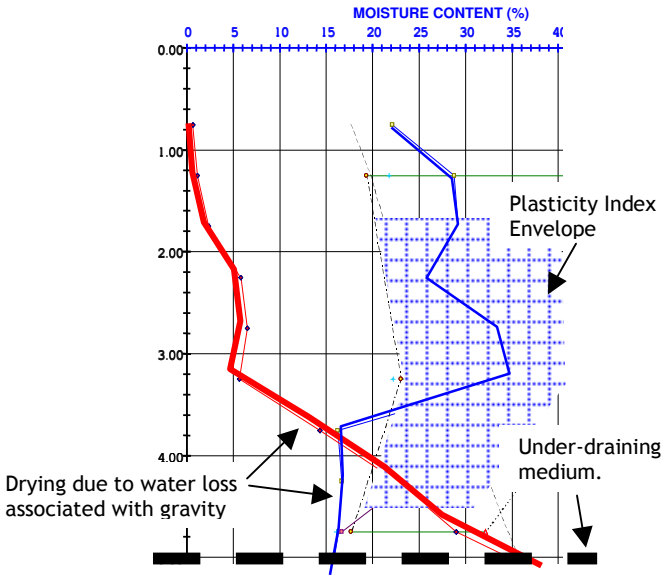
Under-Draining

Leading from the soils research we thought it opportune to explore another cause of high suctions in otherwise linear plots.

When the retention properties of clay soils are overcome by gravity we often see a curve of the form reproduced below. Typically this might be found in the Mercia Mudstone series, where the clay soils overlie sandstone, or shallow beds of London Clay overlying chalk. Any cohesive material overlying a free draining geological layer.

It has nothing to do with the action of tree roots, and is characterised (although not exclusively – mineralogy determines the response) as follows…



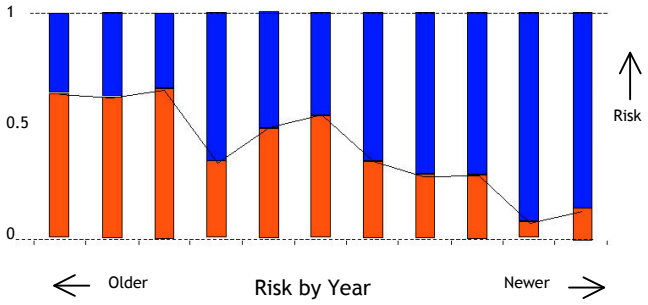
We see the suction profile (red) commences at around 3.25mtrs, and then increases linearly – and quite sharply - until we strike the porous layer represented here by the black broken line. The line isn't characteristic of a root induced problem as it commences a little too deep below ground.

The soil moisture is being retained by the clays electro-chemical forces down to 3.25mtrs, and then gravity exceeds the retention force resulting in drying over a band around 2mtrs thick.

There is a reciprocal reduction in the moisture profile which 'mirrors' the suctions. The Mc falls below the Plastic Limit at around the same level.

Mythology?

We risk straying away from the main theme of our research, but the topic of the buildings response to loss of support beneath the foundation is topical and made us think about the following.



"Lime mortars absorb movement better" is a view expressed by many engineers and surveyors who suggest that cement rich mortars are more vulnerable to cracking. It is a view we have to challenge.

Many old houses with distortions have been repaired and as lime mortar is quite 'soft', it is often useful when re-pointing cracks associated with seasonal, 'in plane' hygrothermal movement. It can disguise minor damage better than cement mortar.

But is has no tensile resistance. If the building drops – or subsides – cracks appear just as quickly for both types of mortar – don't they?

Openings don't change this. They simply change the way the cracks run. Lime mortars do not 'hold the building together' or alter the response at all.

For the average domestic two storey semi-detached house, the risk of cracking revolves around the depth of the foundation as we see in the graph above. We would suggest it has very little to do with the mortar.

Old houses are riskier, even when we do the frequency calculation and even if they have lime mortar. See above. Modern homes are better able to resist subsidence because of the foundation depth, even though they have a hard and brittle mortar.

So, in summary, it has everything to do with the depth of the foundation, and very little to do with the structure of the building – hasn't it?

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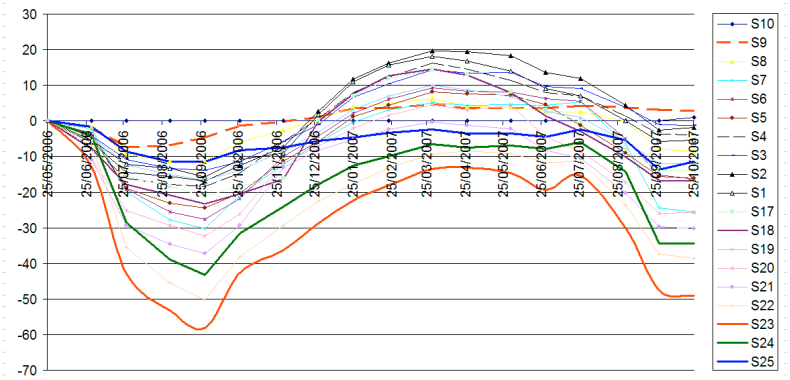
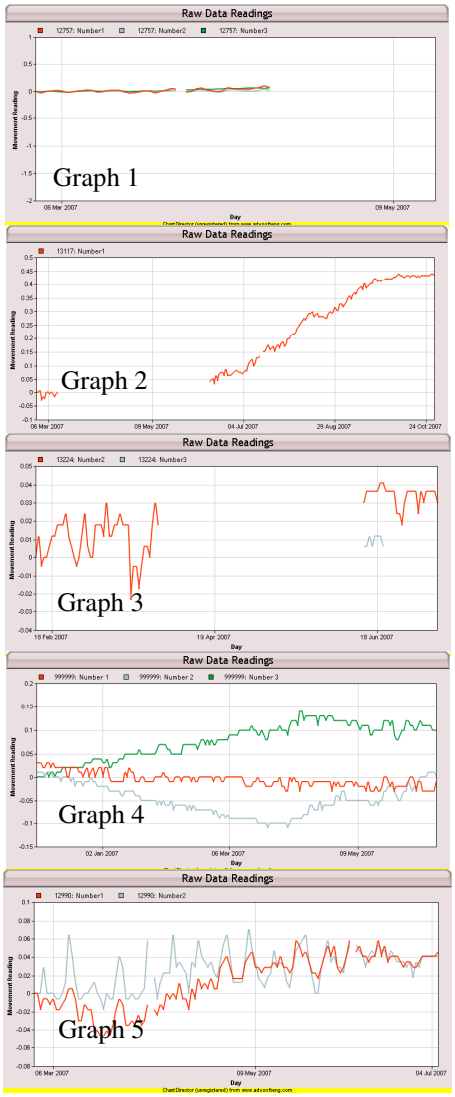
Ground Movement
- Aldenham Willow -

Greater movement at the site of the Willow than the Oak, reflecting the geology. The Oak has a variable mixture of clay, silts, sands and gravels. Consequently (because there is a lower clay content) we see less movement.

In contrast, the Site of the Willow is predominantly clay, and we see twice as much movement.





Telemetry
- Electrolevels -

Graph 1 illustrates stability – this is an example of how electrolevels can assist in supporting repudiations on complex claims. The sensors were removed after two months, leaving the homeowner satisfied with the level of evidence provided. Traditionally this would require at least 6 months, with readings taken every two months. The flat line profile speaks volumes – very quickly.

Graph 2 illustrates a classic clay shrinkage pattern. There has been rotation of 0.45 (exceeding the threshold set at 0.1 to cater for hygrothermal movement) and this has the highest match of all current installations with a 99% probability of the movement being caused by a combination of clay soils and vegetation. The amplitude of the curve suggests a large tree on a highly shrinkable soil.

Graph 3 illustrates how the software handles a dropped signal. It has in-built algorithms to thread together 'loose ends' by taking account of the way buildings behave. This is useful when there are technical glitches relating to battery failure etc., as was the case here.

Many of the 'dropped signal' problems have been resolved by the telemetry supplier, and a new style of sensor has been sourced, at a more economic cost.

Graph 4 is an excellent example of how telemetry delivers benefit. The red line is the datum and shows very little movement. In contrast, the green and blue lines are sensors fitted to each side of a subsiding extension and they are moving in unison, one in a clockwise direction, and the other in an anti-clockwise direction.

Graph 5 is interesting because we see two similar profiles with a 48% probability of being caused by root induced clay shrinkage. This may not appear to be significant, but when we take account of the fact we are dealing with climate, vegetation and a soil with variable mineralogy – and a notoriously difficult time of the year to make predictions (March through to July), this graph would evolve to a much closer fit over time.

Interpretation is a matter of experience and the DataREADER will provide guidance but it still needs the engineer to make an assessment – in this respect it is no different to any other form of monitoring.

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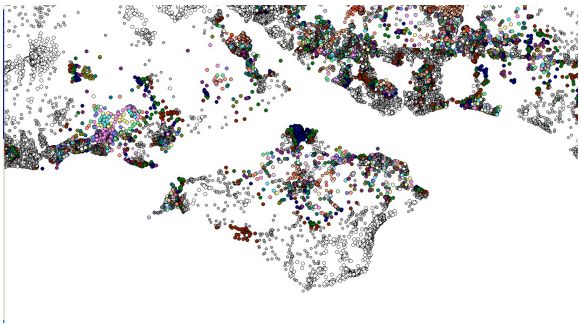
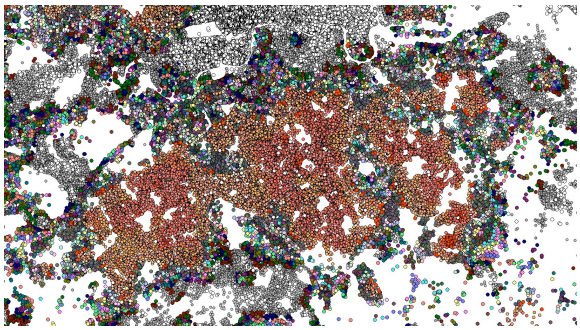
Unit Level Geology

This is the Isle of White, using the unique geological map we have developed for Conversant Data, one of the Innovation data companies.



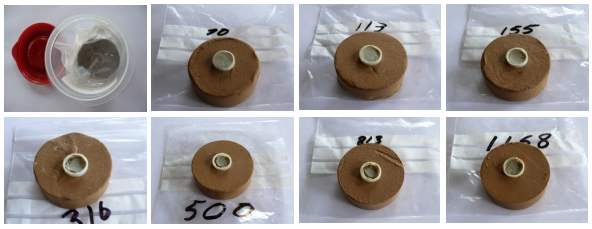
As you can see it is at a very granular level - full unit postcode. It throws an entirely new light on the risk posed by shrinkable clay soils.

Below is London, south of the Thames. Very different to any other map, and yet similar enough to be recognisable. Reds, oranges and browns are higher risk than blues and greys.



Bentonite Test Procedure

Illustrations from Clive Bennett's work at MatLab on replacing the filter paper with bentonite pellets.

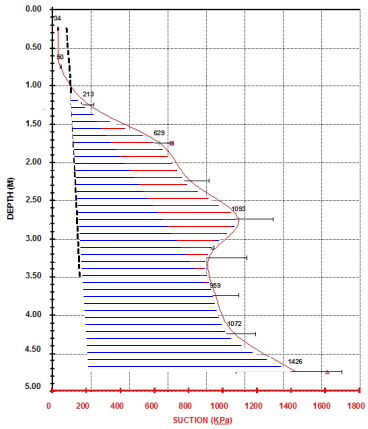


Clive tells us "*this technique offers several benefits. The material is easily calibrated in standard oedometers using the void ratio at 100 and 1,000kPa and its properties well published. It is consistent and 1kg of bentonite would do around 2,000 tests. It is more sensitive over the range of suctions we are interested in.*"

Investigation and Testing Paper

The results of the site investigation data from Aldenham appear shortly, together with a review comparing the various soil tests and interpretation techniques.

One of the more significant findings was the potential to over-estimate swell using the filter paper technique, and we reproduce below one of the illustrations.



Traditionally, and before adjustment, the laboratory estimate of swell would include the blue shaded area. In fact, the true value is far more likely to be the red area only, and then only if there is support using the moistures to show a deficit coincident with this depth. We better understand the need to adjust the Ko line to ensure the above doesn't lead to underpinning or tree removal unnecessarily.

The paper also compares disturbed and undisturbed sampling techniques, the oedometer test and makes recommendations on the interpretation of data.

It appears to be timely – Mike Crilly, Tim Freeman and Richard Driscoll are collaborating on a review paper to explore these topics and it follows from the recent paper produced for CILA by Graham Rex (Cunningham Lindsey) and Tom Griffiths of Expert Services.

The next stages will be exploring the use of a Bentonite Pellet to replace the filter paper. This work – being undertaken by MatLab – could provide a significant advance if successful. Bentonite is a clay with well understood properties and the fact it can be consolidated to fairly precise stresses might remove some of the issues we encounter using the Whatman's filter paper.

See examples left. Here the samples have been consolidated to defined stresses in the oedometer before the bentonite pellets have been added. Initial results are very encouraging.