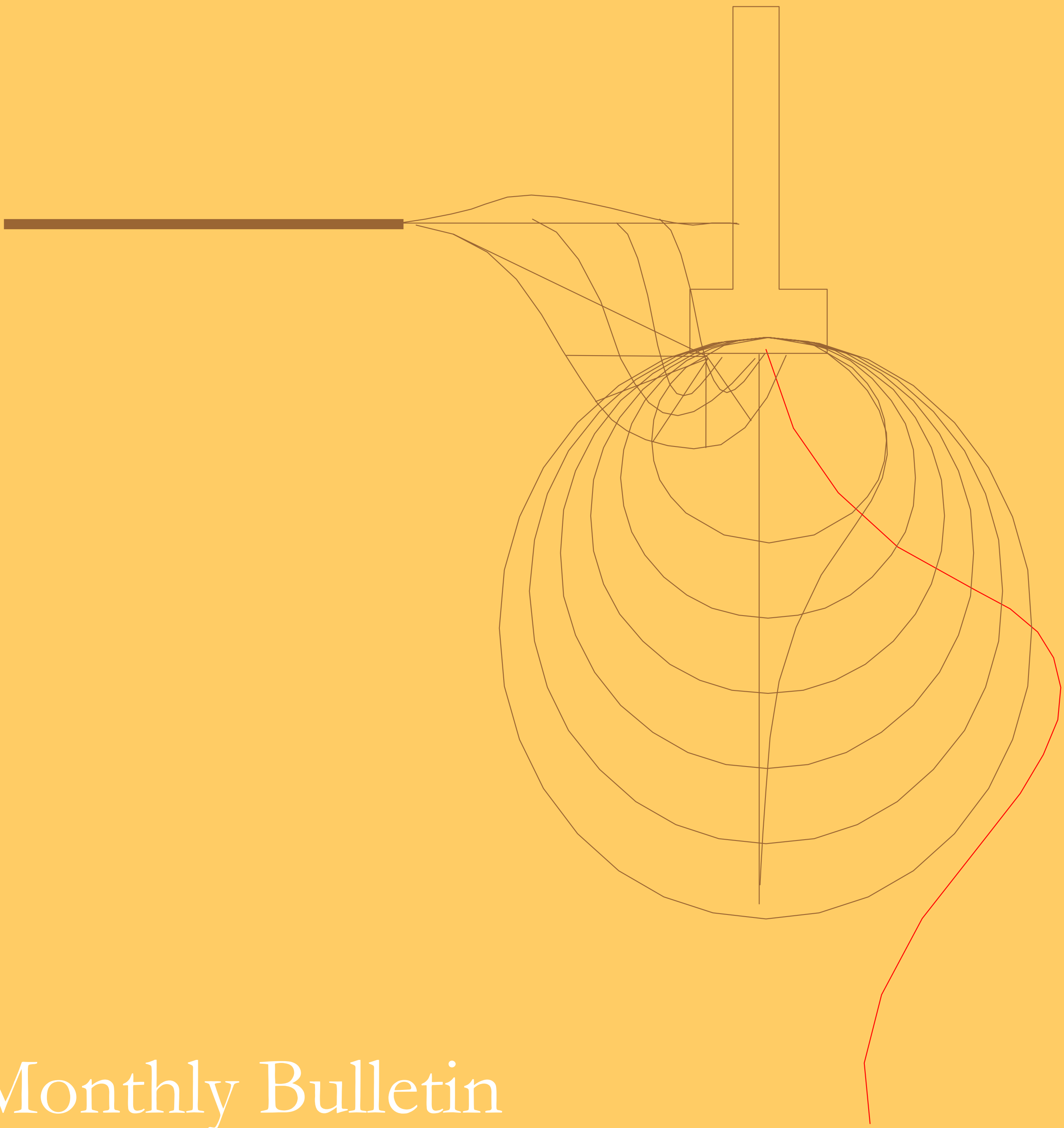
The Clay Research Group



Monthly Bulletin

Aldenham Data Update

August 2006.

Aldenham School

The research site is situated in North West London on outcropping London Clay.

The clay has a Plasticity Index of between 50 – 55%.

We are instrumenting an Oak and Willow tree, both of which are mature and probably in excess of 100 years old.

Both have developed a persistent moisture deficit that extends throughout the winter months.

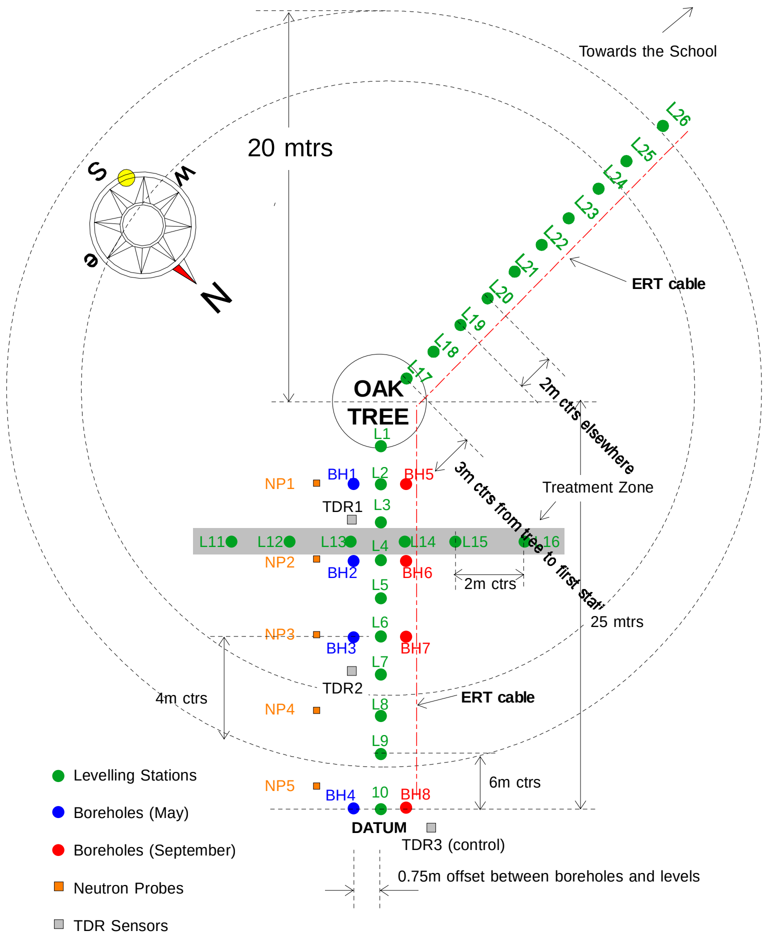
The CRG, via their sponsors, have provided a weather station. Aldenham supply data to the Meteorological Office.

We hope to retain the site into the future, delivering weather and sensor data via the web.

The academic team will develop their climate model based on data gathered and new technologies to assist in the diagnosis and remediation of subsidence damaged houses.

The Oak Site

Aldenham is a dynamic site and instrumentation is agreed between the academics initially, but often changed before we complete the installation. The neutron probe tubes were such a case when our plans had to be modified slightly due to a gravel strike at NP3.



Derek Clarke and Joel Smethurst from Southampton installed 5 neutron probe tubes – see above. NP3 was terminated at 2.5mtrs due to a dense gravel bed. NP1 was taken to 4mtrs, but only after struggling through a gravel lens at 2.5mtrs.

Hence the need for regular updates and revisions. See page 7 for more information on how the installation went.

Tree Supplement

August 2006.

Tree Data

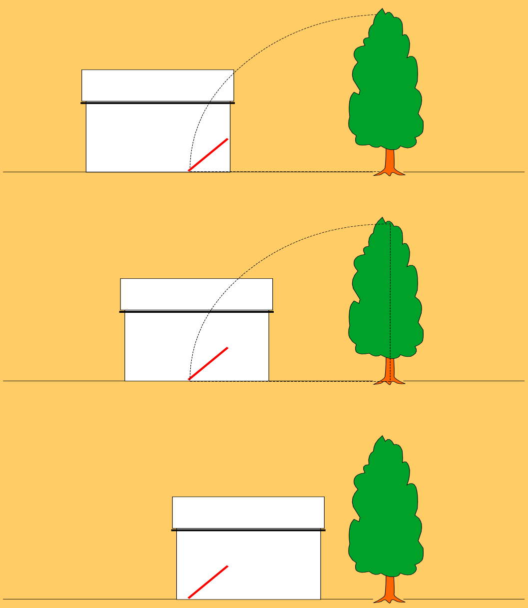
The average height of a tree involved with the claim, irrespective of species, is around 9mtrs, and the average distance to damage (see below) is 6.5mtrs.

Of the sample, 54% claims were caused by the homeowners own tree. 29% involved neighbours and only 13% involved Local Authorities. The balance were either unidentified, or in the ownership of a utility or private Third Party.

Trees grow slowly in the urban environment and 100mm p.a. is probably the average rate, although it varies with species and location.

H/D

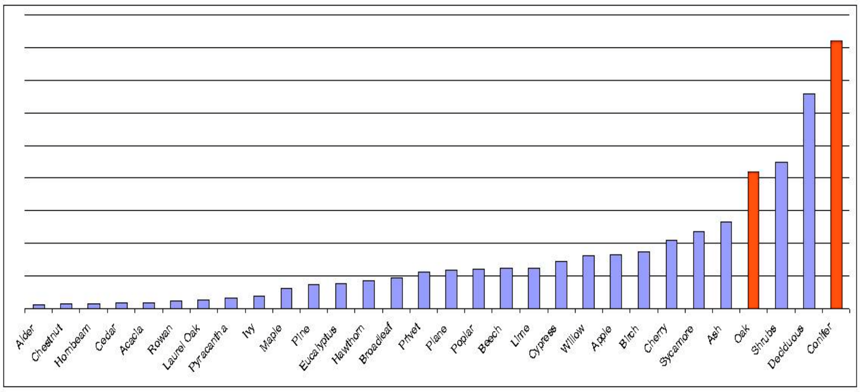
It would appear that 'D' – the distance to the building – is only of passing interest and adds little to our understanding of how cracks develop, or how we analyse risk.



Take a look at the examples above. The "crack to tree" ratio has been fixed, and 'D' is different in each.

Our study (see following page) shows that by far the most relevant measure is the distance to the approximate line of crack propagation, which is usually around 1.2 x tree height.

Trees – Special Edition



Our thanks to everyone who contributed extracts from their database of trees. We now have over 35,000 records, listing tree height, species, and distance to damaged buildings.

We have plotted the rank order of risk, the height at which they present most difficulties and the 'height to distance to damage' ratios. As ever, the more we look, the less we see, but above is a simple 'count of damage in relation to species' plot, with conifers and shrubs at the head of the league table, and Oaks closely behind. No account has been taken of frequency of planting.

What becomes clear from the analysis is, tall, old trees don't always present the greatest risk. From the sample, trees in the 7 – 12mtr tall range are significantly more likely to be associated with damage if we ignore species.

This corresponds with the view expressed by many arborist's. Mature trees don't take up as much water as the younger, more vigorous members of the species. Proof if proof were needed. That said, it may be species dependent as we see below. From the entire population the Oak, Ash and Conifer are exceptions, and do pose a greater threat with height.

From the population of public trees, the height range is 0 – 31mtrs with a mean of 7.6mtrs and a variance of 12.24. The private tree population is in the range 0 – 39mtrs, with a mean of 7.7mtrs and a variance of 15mtrs.

So, trees that cause damage are a representative sample of the tree population and we have to look to the standard deviation for a more meaningful comparison. The SDev for public trees is 3.88 and for private trees, 3.49.

From the 'associated with claims' database, the SDev = 5.6. In summary, there is little to distinguish trees that cause damage from the general population. In fact, proof that 'they take their victims as they find them'?

Aldenham Data Update

August 2006.

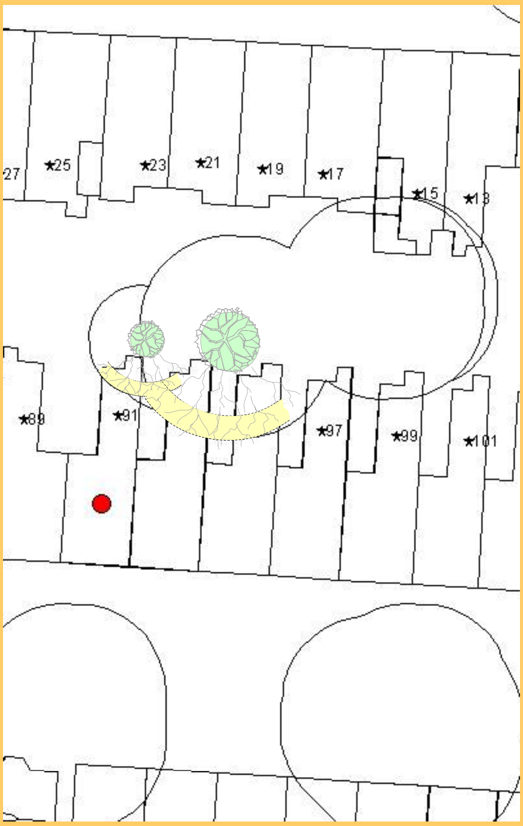
THE ROOT DANGER ZONE

We have been engaged by Addressology Limited to audit the subsidence risk model against actual claims, and found it to be predictive not only in the identification of properties at risk, but also in locating the area of damage in many cases.

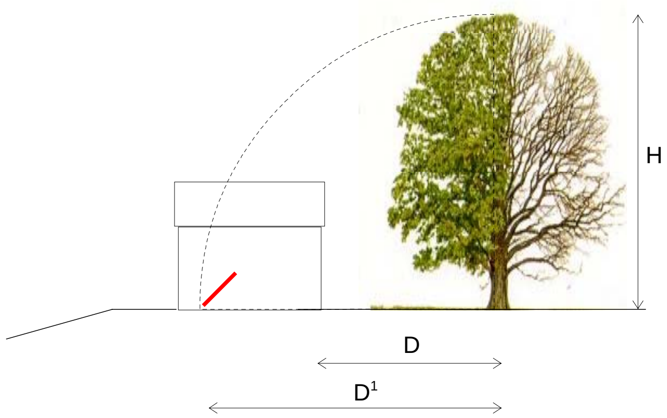
See the example below. Very often (in all cases but one) the area of damage is coincident with the periphery of the root zone. The model correctly identified that No 91 (red dot) was at risk, but went further, correctly predicting what the engineer had said in his report that "there was damage to the rear elevation and the back addition of the house".

This validates the root zone algorithm and will be of use to insurers and adjusters as a tool for triage in time of high claims. The audit continues but the initial results are very encouraging.

The model correctly identified the risk in 96% of the cases reviewed.



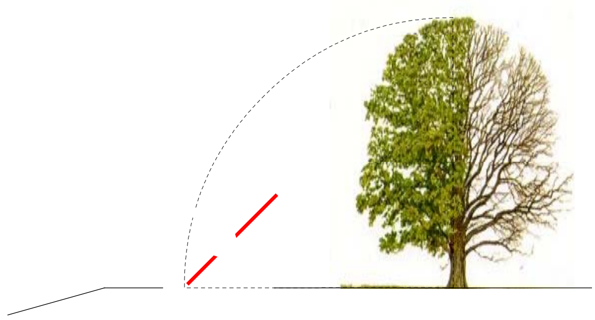
Problems with Distance



As we suggested on the previous page, the distance between the tree trunk and the building isn't the best way of determining tree root influence and risk zones, although it is of course a starting point.

Take the example where a long wall starts say 1mtr from the tree trunk and cracks appear 4mtrs away. The H/D value is largely meaningless.

It would appear from our study that the real zone of root influence is best determined by measuring to the base of the crack – this is the fulcrum of movement.



Apart from the stiffness matrix, the building itself is almost secondary. Our research reveals the 'danger zone' to be around 1 – 1.2 times the tree height, which we equate with the periphery of the root system. The ERT modelling and levelling exercise at Aldenham should help us confirm or refine this. It can be seen how using a H/D value could produce a less than safe risk value.

Aldenham Data Update

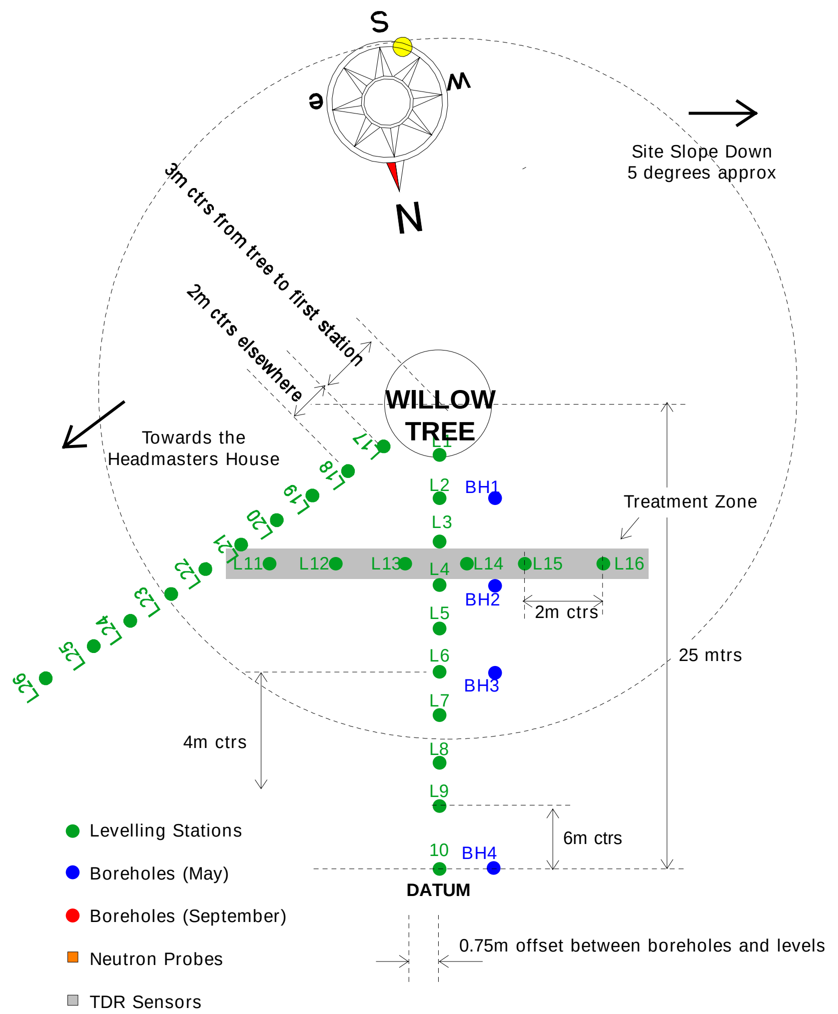
August 2006.

The Aldenham Willow

The willow occupies a gently sloping site (around 5 degrees, sloping down to the West boundary) and the instrumentation is as shown, right. Level stations 1 through to 10 (the datum) are oriented 10 degrees off the North point.

We have a treatment zone and will be sinking boreholes and testing soils and we are taking ERT readings every month. Because of the amount of labour required and the cost of the sensors and dataloggers etc., we will not have the array of TDR sensors and neutron probes.

The soil plasticity index is in the range 42- 49% - slightly less than the Oak site.



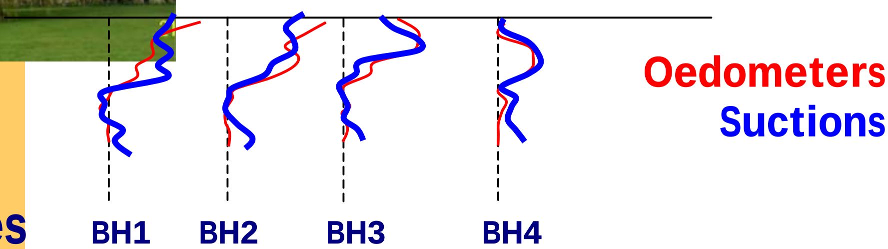
March 2006

May 2006

SOILS TESTING

The results of the soils investigations taken in May reveal very little difference between the soil suctions (using the filter paper) and the oedometer test using disturbed samples for both. This confirms the results from the Oak site.

Boreholes



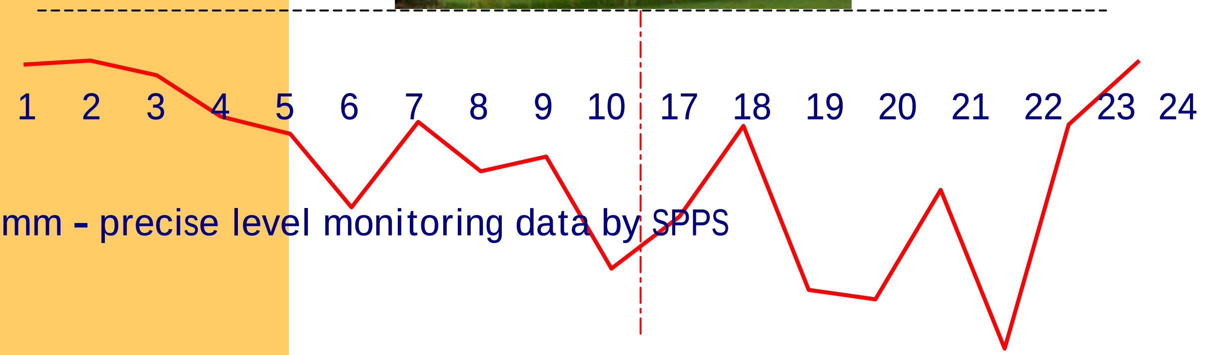
Aldenham Data Update

August 2006.

WILLOW TREE MONITORING

The maximum movement (downward) recorded between May and June was 10.9mm at Station 20 (see plan).

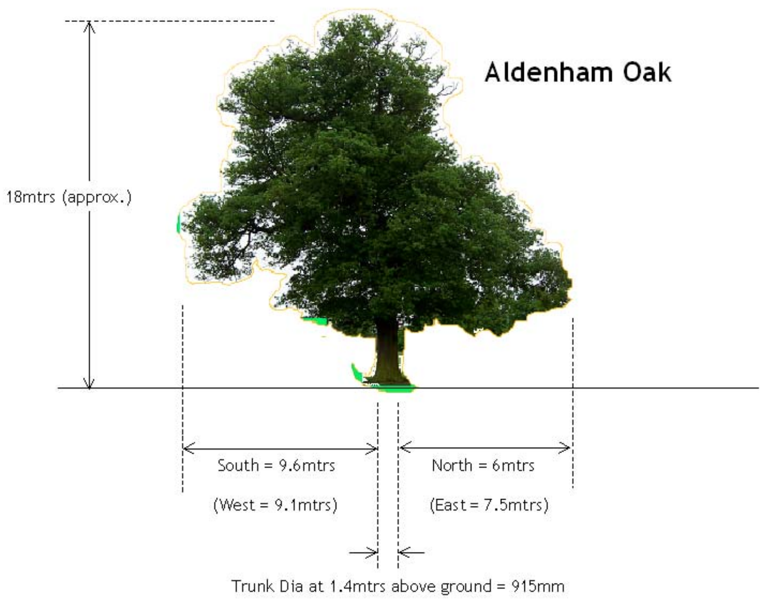
Movement was significantly more along stations 17 – 25 in general (to the right of the photograph below) and more gradual and of less amplitude on the North facing array.



The Aldenham Oak

About 18mtrs tall and over 100 years old, Jon Heuch has provided the dimensions showing a lop-sided crown due to loss of a branch at some time.

The drip line varies around the trunk. The trunk is 915mm in diameter, and the drip line is as shown.



AGE OF TREES

The Oak has a diameter of 91.5cmtrs. Using the old 'a year for every inch of the circumference' idea suggests it may be just over 100 years old, and we think it probably is. If the tree falls down, we will count the rings!

MODELLING GROUND MOVEMENT

Our audit of the 'virtual investigation' applications like OSCAR and VISCAT revealed the following.

The applications correctly predicted tree root influence in 97% of the sample.

The estimate of swell predicted –v- calculated from actual soils data were in agreement in the following bands …

0 - 10mm – 58% of cases
10 - 20mm – 13% of cases
20 - 30mm – 8% of cases

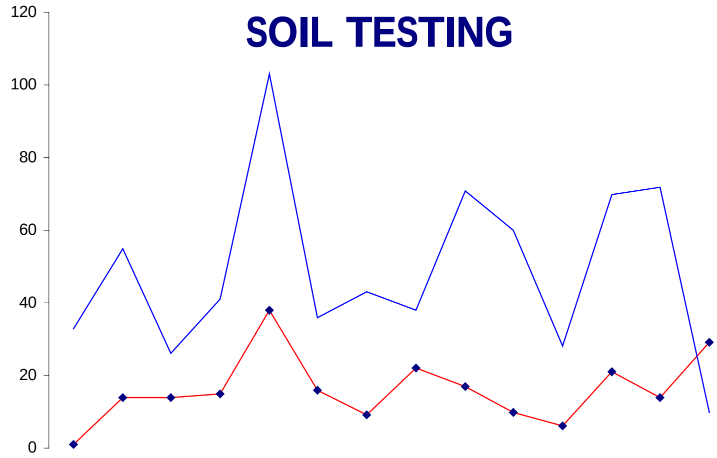
Of the balance (21%), 8% had an incorrectly placed Ko line (i.e. the soils estimate was incorrect).

Precise levels provide a good bench-mark but are not themselves without problems. Correlating the results of the virtual application with precise levels presents difficulties, not least of which is the amount of movement that has already taken place prior to the onset of monitoring. Buildings can subside by say 10 – 20mm prior to cracks appearing, and this reduces slightly the use of precise levels as a validation tool.

The other issue is the fact we rarely have soils data extracted and precise levels taken at the same time and some difference is to be expected in a dynamic situation where movement is taking place continually.

Given the properties of the items we are trying to model (soils, trees and climate) plus the general tendency for tradition estimates of swell to over-estimate ground movement we see significant benefits in these sort of applications and as ever, the more data we have, the more we can refine the model.

SOIL TESTING



In 8% of cases the actual soils data (blue line) over-estimated the estimate of swell due to incorrect plotting of the Ko line. Here, the modelling application was probably closer to the correct values if we made the necessary adjustment. This also reflects the natural tendency for estimates based on soils data to over-estimate recovery.

MODELLING ISSUES

Mature trees, older than the property, are often difficult to model. Where there is a persistent deficit there are likely to be two outcomes. The soils data will confirm high suctions. The virtual models may under-predict. Precise levelling will almost certainly under-predict the potential for heave.

Perversely, the model may find closer correlation to the precise levels as the ground isn't fully rehydrating in the winter.

However, for routine claims, where the trees are younger than the damaged structure it would seem that modelling is a suitable alternative to costly investigations and with experience should correctly identify whether trees are in influencing distance of a property.

LIGHTENING ROD

Derek threatened to call it a day if there was any suggestion of lightening. Below we see him holding the hand auger which was about 6m high as he pulled it out of the ground.

CLIMATE MODELLING

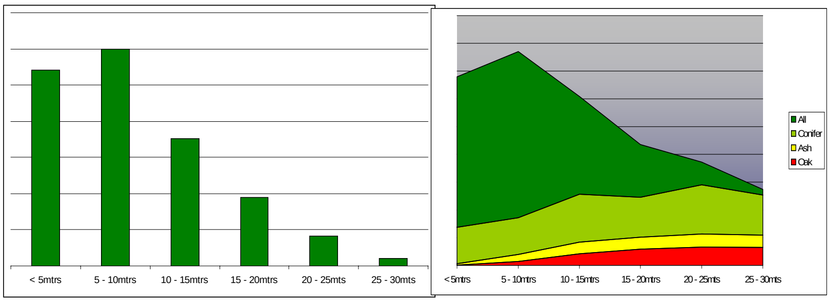
Southampton are modelling climate change and have instrumented several sites in the UK to correlate SMD values with ground movement and going forward, insurance claim numbers. Their findings so far suggest that exceptionally dry and warm summers are going to become the norm over the next 10 years or so.

NEUTRON PROBE

Dr's Joel Smethurst (left) and Derek Clark from Southampton rolled up their sleeves and decided to install the neutron probe tubes themselves. Despite temperatures racing nearly 28 degrees on the day, they successfully sank the hand augers to depths of 4 – 5mtrs through stiff, desiccated clay.

Above we see the yellow cones that are required as part of the Health & Safety Regulations for operating radioactive materials on site. The neutron probe is perfectly safe, as long as we comply with the Method Statement and Risk Assessment.

Height Bands



Left is the height distribution of all trees in 5mtrs bands. Right, we plot Oaks, Conifers and Ash against the entire population. The latter appear to become more of a threat as they grow, whilst the majority of trees peak at between 7 and 9mtrs.