Heave: not all it is cracked up to be

Challenging the myths around heave – and exposing the nonsense of phased tree removal

Martin Dobson

This article challenges several deeply rooted but mistaken beliefs held by engineers, surveyors, and arboriculturists – ideas that are too often repeated as though they were established scientific fact.*

As a result, clients are too often given poor advice, albeit in good faith. The aim here is simple: to replace loose assumptions with a clearer, evidence-based account.

How clay-related movement occurs

A significant proportion of the UK's housing stock is built on clay soil. Unlike sand and silt, clay is shrinkable: it contracts as it dries in summer and swells again when it re-wets in winter.

Vegetation intensifies this natural cycle, particularly trees and shrubs. Evaporation from bare ground can dry clay to a depth of about 0.3 m, and grass can do so to about 1 m, but trees and shrubs can potentially dry clay to depths of 2–5 m.

If foundations do not extend below the zone of seasonal drying, part of a building may become unsupported. The structure can then move down in summer and back up in winter. Where that differential movement is great enough, cracks appear in late summer. This is known as clay-shrinkage subsidence damage.

If the offending tree or trees are felled promptly, the soil will usually recover over a single winter and the building will stabilise. This upward movement simply returns the building to its original design level and is best described as recovery.

Persistent soil moisture deficit and extended recovery

Sometimes the offending tree is not dealt with promptly, often because the owner is unconvinced that the tree is causing the damage or because the tree is protected. In those circumstances, subsidence may continue into a second growing season or beyond.

In a limited number of cases, the continuing influence of the tree leads to a persistent soil moisture deficit (PSMD). This occurs when the clay subsoil does not rehydrate to its equilibrium moisture content over winter, so part of the deficit is carried forward into the following summer. The PSMD may then increase progressively from year to year, causing the building to ratchet downward.

If the tree is later felled, the soil may take several winters to return to equilibrium and the building will take the same time to return to its normal level. This process is better described as extended recovery. Once the deficit has fully recovered, the building should stabilise at its original design level.

If that recovery is expected to take too long, the building may need to be stabilised by deepening the foundations below the PSMD and including anti-heave precautions. In that situation, there is no advantage in felling the tree.

Heave is different – and rare

A different risk arises when a tree that created a PSMD is felled and a building is then constructed shortly afterwards without proper allowance for soil recovery. In that case, the building may experience differential upward movement that carries it above its original design level. Crack damage caused by this mechanism is known as heave.

In practice, heave is uncommon. It accounts for insurance claims only in the low hundreds each year, whereas subsidence accounts for tens of thousands. Heave should therefore be regarded as very rare.

Three types of upward movement: a summary

To summarise, Figure 1 shows the three categories of upward building movement caused by the recovery of desiccated soil.

- **Recovery:** upward movement of a building caused by a seasonal moisture deficit that fully recovers within a single winter.
- **Extended recovery:** upward movement caused by the gradual recovery of a persistent soil moisture deficit over more than one winter, where the PSMD developed through several cycles of subsidence.
- **Heave:** upward movement of a new-build structure caused by the recovery of a PSMD after the prior removal of a tree. This movement will usually begin soon after construction and may continue for several years.

**In 2018, I spoke at the Arboricultural Association's annual conference, Soils and Trees – Standing your Ground, under the same title as this article. This piece is a belated follow-up to that presentation.*

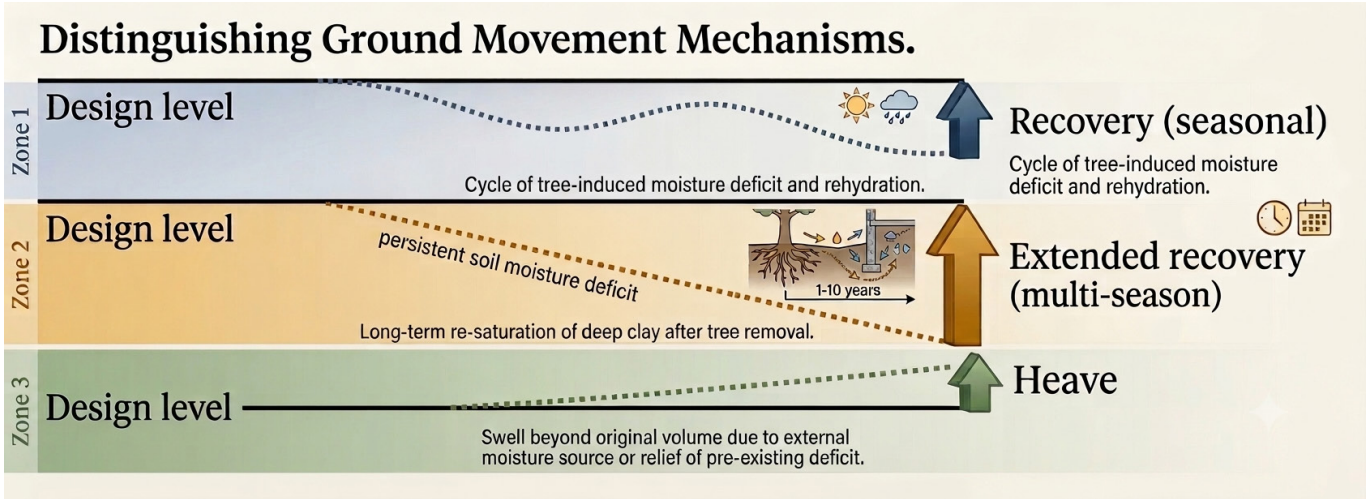


Figure 1: Illustrative diagram to show the three categories of building movement related to rehydration of a desiccated clay soil. (generated using AI)

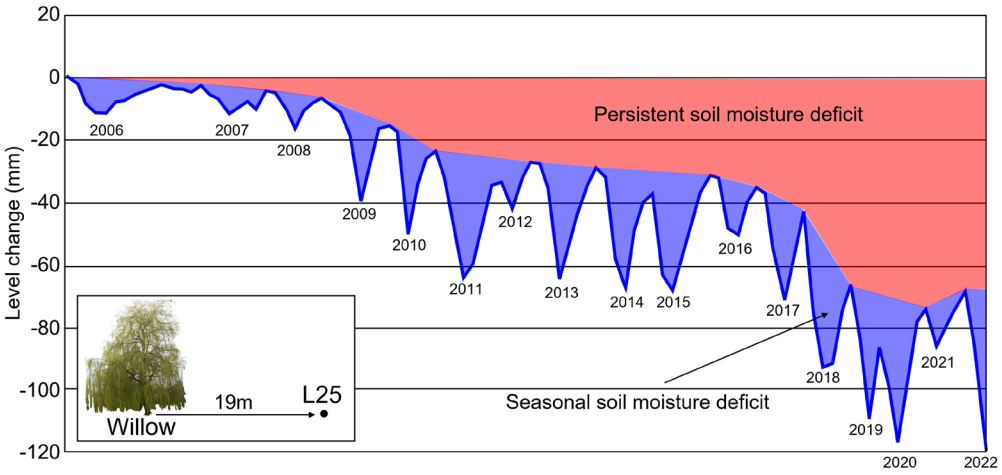


Figure 2. Monitoring results showing changes in soil surface level on London Clay at Aldenham School, Hertfordshire, 19 m from a willow tree. Over the monitoring period, a persistent soil moisture deficit developed (pink shading), with a seasonal moisture deficit (blue shading) superimposed on it.

Does felling a tree create a risk of heave?

A common assumption is that felling a nearby tree will probably cause heave. In my view, that claim is greatly overstated. Others have said so too. In January 2013, engineer Mike Duckworth of loss adjusters Cunningham Lindsey produced a discussion paper for the Subsidence Forum entitled 'The assessment of heave in clay soils'. He wrote: 'It is often thought that recovery/heave will necessarily occur if a tree is removed. This is not the case. There has to be a moisture deficit and if there is no moisture deficit then there cannot possibly be any significant clay swelling'.

The principle is simple. A tree cannot have created a pre-existing persistent soil moisture deficit if it was planted after the house was built. In those circumstances, felling the tree does not create an unreasonable risk of heave.

The harder question is what happens when the tree was already there before construction. My answer is still unequivocal: there will be no heave – provided there is no active or historic subsidence. Where there is current or past subsidence, soil investigations may be needed to determine whether a PSMD exists and, if so, to assess the potential duration of recovery.

Why I am confident

That confidence is grounded in research by the Clay Research Group at Aldenham School in Hertfordshire, on London Clay. Since 2006, changes in soil surface level have been monitored there. Figure 2 shows an annotated record for marker L25, located 19 m from a willow tree. Over time, the willow progressively dried the soil, causing the surface to subside and demonstrating the development of a significant PSMD. The data also show a seasonal cycle of wetting and drying, with shrinkage and swelling superimposed on that longer-term deficit.

The key point is that desiccation is not static: it is dynamic and either increases or decreases over time. If a tree had enough influence to create a PSMD before a house was built, a property with foundations that are too shallow would be expected to show subsidence relatively soon after construction. If no subsidence is present, that is strong evidence that there was no PSMD to begin with.

A practical rule of thumb

When I am asked, 'Will my house suffer from heave if I remove the tree?', I start with two questions: 'Is your house currently suffering from subsidence?' and 'Has it ever suffered from subsidence?' If the answer to both is no, I am generally satisfied that removal can proceed safely.

Why phased tree removal is misguided

That brings us to the related issue of phased tree removal.

Here is an extract from a recent chartered surveyor's report which is a good example of the sort of advice that is still being given: 'It may be necessary for the trees to be cut down, this would need to be carried out with caution as the sudden removal of trees has the potential to cause ground heave due to dramatic altering of the moisture in the soil; this can cause damage to building structures, although it is more prevalent in clay soils. Sometimes it is necessary to cut down trees in stages, giving some time between each stage to allow the soil to adjust to changes in moisture levels'.

There are a number of points to raise in response to this:

- **Heave is not 'more prevalent' in clay soils**. Heave only occurs in clay soils, and even then it is rare.
- **Sudden removal does not create more recovery than phased removal**. Whether removal is immediate or gradual, the same total amount of recovery will occur. The real issue is not how quickly the soil swells, but how much upward movement takes place overall.
- **Phased felling has been discredited for decades**. As Dr P.G. Biddle explained in 1992, 'phased removal of a tree over several seasons has no advantages but merely prolongs the period of recovery'.

Key takeaways

The key points are these:

1. Heave is very rare. It usually arises on sites where one or more trees have been felled and a house has then been built without proper allowance for soil rehydration.
2. Heave will not occur if the tree being felled is younger than the building.
3. Heave will not occur if a property has never experienced subsidence, regardless of whether the tree being felled is older than the building.
4. If a persistent soil moisture deficit has become established through successive cycles of subsidence, phased felling will do only one thing: prolong the period of soil rehydration and building recovery.



Dr Martin Dobson started his career in arboriculture at Forest Research before working for two years at the Arboricultural Advisory and Information Service. He launched his own arboricultural consultancy in 1997. He has prepared hundreds of expert reports where trees are involved in litigation, particularly on tree-related subsidence and tree failure cases.