

Key Steps in Building Movement Investigation

This article is intended for those reviewing building movement investigation reports, to assist assessment of adequacy of investigations and reports. The treatise is limited to cases of reactive foundation movement.

Introduction

Building movement occurs for many reasons. Commonly featured in disputes is reactive movement, usually of houses. This is when changes in the foundation moisture causes buildings to move out of level, commonly causing cracking and other distress. Although there is nothing to stop an expert expressing an opinion on such a matter without fully investigating or explaining his logic, it is best practice is to adopt a step by step logical approach. All too often key steps are omitted without explanation and a list of these can be useful in scrutinising an expert's report or examining his opinion.

Step 1: Measure the Movement

The minimum requirement here is to take levels to quantify how the building has moved out of level. Ideally these should be benchmarked to the original constructed levels to Australian Height Datum to confirm the movement. In most cases the original levels are not available, so the levels recorded show only the level irregularity. They do not show if the entire building has moved up or down. Often level irregularity is sufficient as the irregularity causing distress is the issue rather than global movement.

Step 2: Rule Out Construction Irregularities

No building is constructed exactly to level. In cases where parts of a building are out of level by small amounts, it may not be clear if this is a construction irregularity or movement. There are two common indicators of movement: A pattern, such as one corner being low, and distress being consistent with the movement. By correlating these observations with the level pattern we can determine where irregularity has been caused by movement. In cases of gross movement, such as when a house is 100mm out of level, this step may not be necessary.

Step 3: Check Site History

As we move towards diagnosis it is useful to look for abnormalities in the site history. Examples include vegetation prior to construction and odd drainage features. I currently have a file where over 100mm of movement has occurred largely as a result of a tree removed shortly before construction. Such influences may be major issues on the highly reactive sites. Google earth and Nearmap are often sufficient to identify potential issues. An important point that arises from this is that if the site was built upon with an abnormal moisture profile it is usually impossible to know that profile with any accuracy so attempts to measure foundation moisture or rectify it post hoc will be challenging.

Step 4: Check Plumbing

Given that we are discussing movement due to abnormal foundation moisture one could be excused for thinking that checking plumbing for leaks would be routine but this is not always done. In reactive foundations plumbing leaks commonly cause heave by causing clays to swell. Thus there will be cases where checks are not required as movement is obviously settlement. Plumbing checks should be accompanied by a report confirming what has been checked and describing any issues identified. Checks should include roof gutters for overflow, in ground stormwater, sewer and water supply. Details such as hot water overflows and air conditioning discharges should not be overlooked.

Step 5: Review Movement Pattern

With a site plan showing possible sources of wetting or drying in front of one and a contour plan showing how the building is out of level, it is usually possible to identify likely issues with confidence. Figure 2 is a simplified contour plan of a representative situation. Relationships between influences and movement are not always as straightforward as this illustration. Waffle pod slabs, in particular, often present difficulty as the excavated surface under them is nominally level so it is difficult to predict water flow. A plumbing leak on one side can make its way across the subbase and cause heave elsewhere.

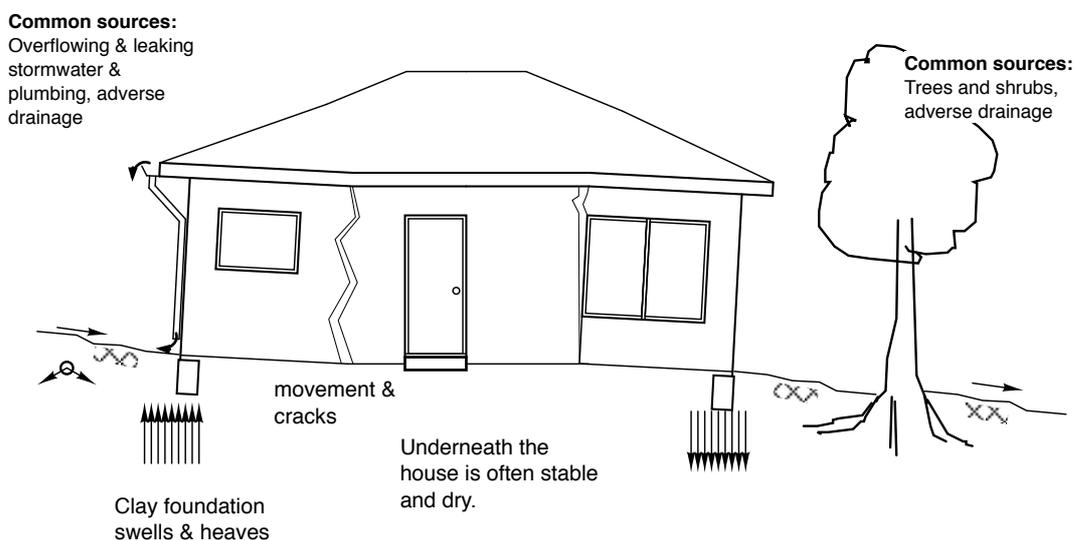


Figure 1: Causes of settlement and heave are sometimes obvious, but not always....

Step 6: Geotechnical Investigation

If the foundation type is not well known, some kind of geotechnical investigation is often necessary. However, in most cases a pre-construction geotechnical report is available. When the nature of the foundation is clear and we know we are dealing with a reactive movement problem why do we need further geotechnical investigation? Such investigations may provide a moisture profile. This can be useful if the movement pattern does not demonstrate where the foundation is wet or dry but in marginal cases it is rarely useful. Soil moisture contents are a very sensitive measure, they are only meaningful in comparison with other samples in exactly the same material at exactly the same depth at the same time of the year. When such data is rarely available from earlier in the project's history, soil moisture investigations may not be useful. Thus in some cases, this step may be omitted.

Step 7: Footing Investigation

This may be conducted with the geotechnical investigation for the purpose of confirming the footing profile and depth. In cases where the designed profile is clear and inspections have been passed, this may not be essential. Footing investigation is more often useful when there is serious doubt that the appropriate footing has been constructed. In modern house slabs this is unusual.

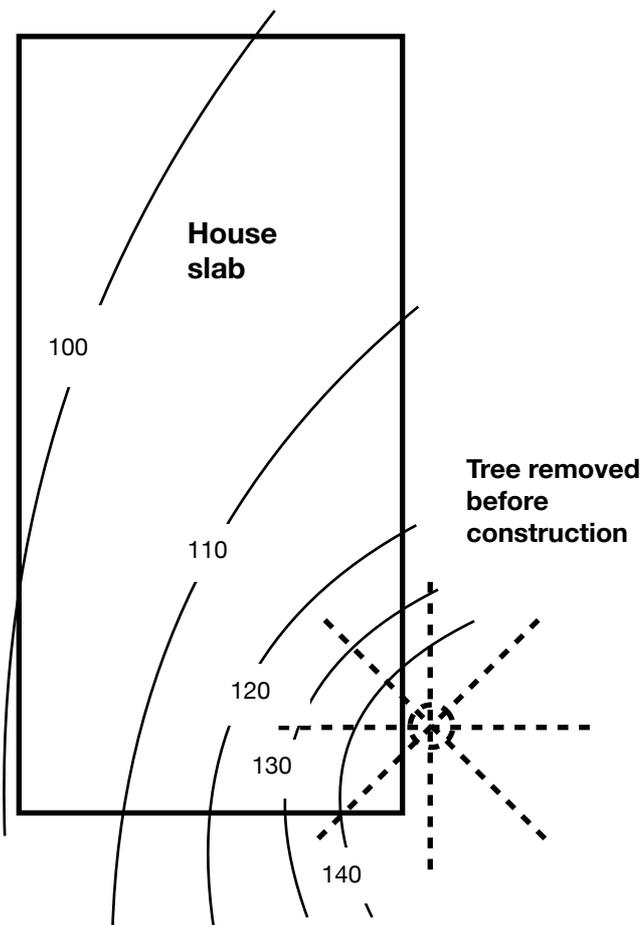


Figure 2: Simplified contour plan showing heave from tree removed

Step 8: Is the Building Defective?

This can be a very important step in dispute resolution. It may be clear that the building has moved or distressed but is it defective by any formal criteria? AS 2870 provides performance criteria similarly to those in the Victorian Building Authority Guide to Standards and Tolerances. For most cases there are two families of defect criteria, distress and irregularity of level. The distress criteria are generally liberal. It is possible to have a house with extensive unsightly cracks and a major movement problem that complies with these. The criteria for level irregularity are limited and do not cover many cases: For instance, after two years, there are no criteria for overall differences in level. Movement may present as unacceptable but not meet defect criteria. Sometimes one can put aside objective criteria and address whether the movement is abnormal and has been caused by a defective in construction or design. An argument may then form that it is defective, independent of explicit criteria.

Step 9: Are Remedial Works Required?

This is not always obvious. If movement and distress is minor, remedial works may not be required. It is important to consider this against a background where a property owner should reasonably expect to carry out occasional repair and maintenance works including repairing minor cracks and re-painting periodically. Is the scope of works clearly beyond that?

Step 10: What Remedial Works are Required?

Courts and tribunals and reasonable ethical standards encourage experts to consider alternatives. If a report doesn't do this, it should explain why.

In most cases of reactivity foundation movement problems the first alternative is to mitigate the cause and repair the damage. Mitigating the cause may mean removing or isolating a tree, repairing plumbing or improving site drainage. If a foundation has been abnormally wet or dry it should then improve and the building can be repaired. A problem with this approach, particularly in the dispute environment, is that it usually takes a length of time that is difficult to estimate and rarely achieves full recovery. It may, however, be visited as option 1 at least for discussion purposes. Other alternative such as underpinning, reconstruction etc can then be discussed and their advantages and disadvantages weighed. It may be up to the court, tribunal or negotiating parties to agree or determine such scope, particularly if it is effectively the ultimate issue.

About the Author

Patrick Irwin is a forensic structural engineer with extensive experience in the building dispute field.