Heritage Council of New South Wales

Cracking of Buildings due to Shrink/Swell in Clay Soils

Purpose

The purpose of this technical note is to provide basic guidance to the owners and custodians of heritage buildings which are suffering cracking due to shrink and swell in clay soils. There are many potential causes for cracking and approaches to mitigating the problem. Specialist engineering and geotechnical advice is usually necessary.

1.0 Cracking of masonry buildings built on reactive soils is a common issue throughout Australia wherever clay soils of significant depth underly buildings.

Reactivity refers to the tendency for the clay soil beneath the footings to shrink and swell with changes in moisture content which can lift and lower the building. The major factors influencing this are:

- The ability of water to reach the clay material beneath the footings;
- The composition of the soil;
- The depth of the soil;
- The effect of trees.

2.0 Is the cracking in my building due to shrink/swell in the subsoil?

There are many other potential causes of cracking to masonry buildings including:

- consolidation of poorly compacted soils (either natural soils or fill) when loaded with the weight of a building;
- vibration causing consolidation of soils (eg traffic, construction activities, earthquake, mining blasting);
- mine subsidence due to underground tunnelling;
- wash out or softening of the ground below the footings due to saturation by subsurface flow (eg stormwater or broken service pipes);
- corrosion of lintels or embedded steelwork or decay of embedded timber within walls;
- earthquake or wind loads;
- deterioration of materials (eg failing rubble walls)

3.0 Engineering advice: It is recommended that a structural engineer's advice is sought to determine the probable cause of cracking and advise on further action. Qualified engineers are usually advertised in the yellow pages under *Engineers Consulting.* Names may also be obtained through the Institution of Engineers Australia and the Association of Consulting Engineers Australia. The structural engineer will also advise whether geotechnical advice and investigation is necessary.

If your building is of heritage significance it is recommended that your engineer has heritage experience.

4.0 There are several options for treatment of problems due to shrink/swell in clay soils.

- **Control of water sources** : All piped services in the ground should be checked by a plumber to ensure that there are no breaks or leaks leading to periodic local wetting of the subsoil. This includes sanitary drainage, stormwater and water supply services. External water taps and downpipes should discharge into drains not onto the ground.

  Irrigation systems that maintain a reasonably constant moisture content in the soil may be acceptable however those that are used only periodically may exacerbate wetting and drying cycles. Generally it is preferable not to have planting or irrigation systems immediately adjacent to walls of buildings in reactive clay soils. Flower beds should be separated from the building by paved areas in the order of 2 metres wide, if possible.

- **Tree root control** : the presence of trees near the building (eg within a distance of 2 x tree height from the walls) will exacerbate shrinkage in clay soils as the tree sucks moisture out of the ground. Trees can be a major contributor to shrinkage in reactive soils. Options include installation of cut off walls for root control with appropriate root pruning (an arborist's advice is required to ensure tree health and stability is maintained) or removal of trees within the influence zone of the footings. The influence zone will vary with tree size and type, soil type and landform, consequently an arborist's advice and possibly trial excavation to determine extent of roots is necessary. Works to trees generally require Council approval.

- **Moisture control to the building perimeter** : this is a strategy whereby the changes in moisture content below the footings are minimised by appropriate site grading, drainage and moisture control devices.

  The purpose of moisture control devices is to maintain a stable water content in the soil below the footings by creating an increased path length for evaporation to the surface.

  Typical systems include:

  - paving to the perimeter of the building;
  - cut off walls to the perimeter of the building;
  - buried impermeable membranes around the building;
  - a combination of the above;

- drip irrigation systems to maintain moisture content in the soil.

These approaches can assist in minimising ongoing movement but will not eliminate it. These methods are however generally considerably less expensive than underpinning.

Moisture control aprons have potential problems in that if damp proof courses are inadequate the increased moisture levels can exacerbate rising damp in walls. They can also increase moisture content beneath houses leading to conditions which could exacerbate mildew, fungal rot and insect attack. Consequently, their use may need to be coupled with repair or installation of a damp course and maintenance or installation of appropriate underfloor ventilation. The potential problems caused by increasing moisture content therefore have to be balanced with the advantages in reducing reactivity.

- **Underpinning**: this is the most complete solution whereby the footings of the building are underpinned with either concrete, masonry or piles to carry the load of the building down to a more stable stratum (eg rock or soils below the reactive zone).

  This solution is usually the most costly, particularly if there are access difficulties or if internal walls require underpinning, which may require lifting internal floors.

5.0 Subsoil drains : Subsoil (or agricultural) drains are often used to control stormwater in association with site grading. Subsoil drains are useful in preventing excessive saturation of the soil however should not be used immediately adjacent to external walls. Free drainage adjacent to the walls can have the effect of increasing the rate of wetting and drying. Consequently, subsoil drainage is only recommended at the perimeter of paving and generally at least 2 metres away from external walls. Site grading and paving should grade away from the walls towards such drains. The drains should not be too deep in case they dry out the soil excessively.

6.0 Repairs to cracked walls. Once a wall has cracked it can be difficult to prevent recurrent cracking at the same location. If underpinning has been used it may be possible to repair cracks without significant risk of re-cracking.
If moisture control methods have been adopted, without underpinning, then continued, albeit minor, movement is likely to occur.
Cracks can either be repaired and be allowed to re-crack (although to a lesser extent) or can be filled with flexible sealants to allow for minor movement.
An alternative is to install articulation joints at selected locations so that movement is handled in a controlled manner in selected discrete locations (eg a vertical joint in the wall behind a downpipe).
Crack repair can consist of raking out and refilling open joints (matching existing mortar in porosity and strength), replacing bricks, rebuilding sections of wall or can include stitching across cracks with stainless steel reinforcing bars.
A structural engineer's advice should be sought regarding appropriate methods of crack repair and advice on the risk of re-cracking.

References

Australian Standard AS 2870 *Residential slabs and footings.*
Stabilizing Heritage Buildings Founded on Reactive Clay, J W Jordan, B J Collins – NSW Heritage Office Library
Guide to Home Owners on Foundation Maintenance and Footing Performance by P F Walsh CSIRO Sheet No. 10-91, July 1986, CSIRO Information Service.

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May 2004