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DIVISION OF BUILDING, CONSTRUCTION AND ENGINEERING

information sheet

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# TREES AND FOUNDATIONS

*by D.A. Cameron*

Tree roots may damage the footings of buildings in two ways:

- by direct physical contact; or
- by removing soil moisture, which causes shrinkage of clay soils and subsequent settlement of adjacent footings (conversely, the removal of trees from a site eliminates their drying effect and permits soil wetting with subsequent soil heave).

The roots of some trees which develop large base structures (e.g. figs, willows and liquidambars) may cause direct physical disruption of minor structures such as *footpaths, fences or simple retaining* walls. Damage to houses, however, is far more commonly associated with clay shrinkage.

The severity of shrinkage settlement damage depends on a number of factors.

Firstly, damage is most likely to occur in climates ranging from temperate to semi-arid. Damage frequently becomes noticeable during the dry season, particularly when drought conditions apply.

Only clay soils are capable of shrinkage settlement. Clays shrink or swell with loss or gain of moisture, and they can vary in their ability to change volume. Therefore, *the severity of damage at a particular site* will depend on the nature of the clay soil.

The soil profile (the arrangement of soil layers below the surface) affects the pattern of root development and consequently the potential zone of soil drying. In a soil profile consisting of heavy clays, roots tend to be confined to the top metre of soil and so may spread greater distances laterally than in lighter clays. Roots will also avoid penetrating rock layers and water tables.

The position of footings in the soil profile is also important. If the base of the footing is carried through shrinkable clay soils to firm sand or bedrock, shrinkage settlement of the footings will not occur.

Tree roots can spread laterally between 0.4 and 2 times the height of the tree. If wet areas exist across a site, root growth will concentrate in these areas. In this respect the locations of abandoned septic tanks can be important. Roots can spread further than normal under certain circumstances. For example, large paved areas prevent evaporation and lead to moisture build-up. Trees planted at the edges of paving quickly develop roots to feed from this moisture. Normal site drainage prevents replenishment of the soil water, and the roots will extend further. Also, trees planted together in clusters or rows compete for the available soil moisture and so develop more extensive root systems.

The species of tree determines its water demand, hardiness and pattern of root growth. Deciduous trees, which have a high water demand during the drier seasons, are more likely than evergreens to cause settlement damage.

Unfortunately, little relevant information is available about different species characteristics. Some guidance on trees which appear to be effective water seekers, and therefore best avoided, is given in the list on the final page. Trees not on the list will also cause problems if planted injudiciously. For example, the popular silver and black wattle trees have often been implicated in house footing problems in the Melbourne area.

Damage due to local soil shrinkage settlement can be minimised if footings are sufficiently stiff or rigid. For new houses, stiffened raft slabs provide a particularly rigid floor system. The rigidity of the alternative system, strip footings, can be improved by increasing the depth of the footing. Alternatively, where extreme settlements are expected, the house may be supported on concrete piers or driven piles based below the depth of soil drying caused by the trees. Unfortunately, old houses often have shallow bluestone or concrete footings which are not rigid and are therefore highly susceptible to damage.

### Tree planting rules

In the majority of cases, single trees will not interfere with footings if they are planted at a distance greater than their expected mature height. Where a group of trees are in close proximity, the minimum planting distance must be increased to 1.5 times the mature height of the trees.

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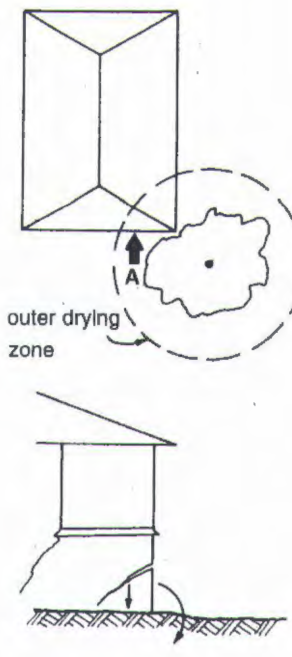
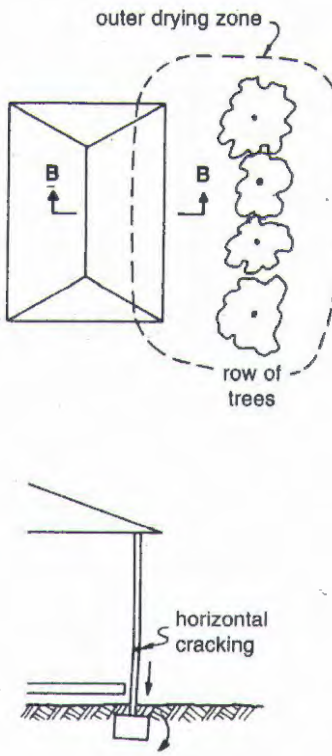



**View A**
**Local corner settlement**




**View B**
**Settlement of side of house parallel to row of trees**

In Melbourne, the particular combination of soil factors and climate dictates that damage to brick-veneer houses on shallow footings is unlikely if all trees are located at a distance away from the building equal to or greater than 0.75 times their mature height. Trees can be planted closer provided some of the factors already discussed are favourable.

## Repairing the damage

If trees are suspected of causing damage, consideration should be given to their removal. Soil swelling may take place after their removal, as soil moisture is regained. Generally, this means that some recovery of structural cracking is possible. The extent of recovery is highly dependent on the behaviour of the particular clay soil after undergoing numerous wetting and drying cycles. The period of recovery may take up to one year depending on the soil porosity and whether or not the ground is soaked after felling. Advice on effective soil watering is given in Information Sheet 10–88. Rigid fillers should not be used to repair building cracks during the recovery period.

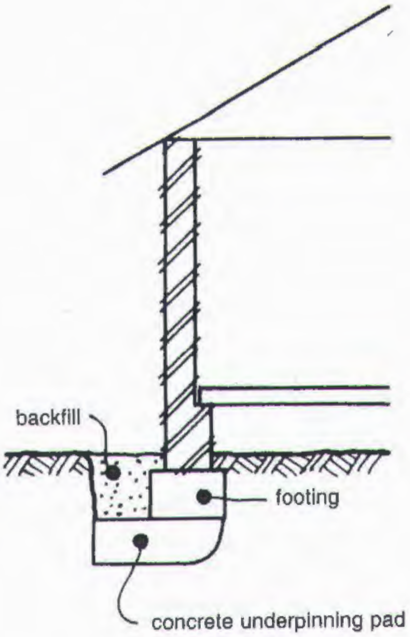
If a tree much older than the building is removed, subsequent soil swelling may be sufficient to cause even further structural damage. Advice from a foundation engineer should be sought in such cases.

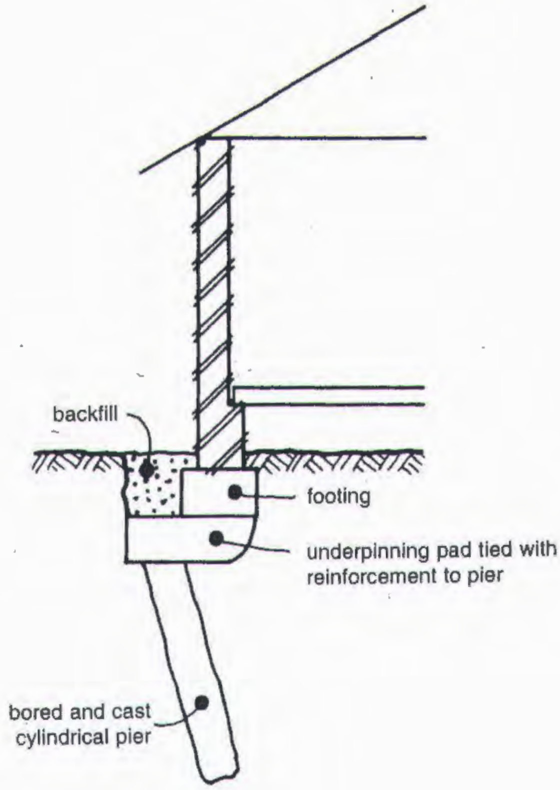
If it is desired to retain the troublesome trees, four alternatives exist. Sometimes, soaking of the soil near the foundations and trees can alleviate low levels of damage. However, during the critical dry periods, water restrictions may be in force. Gardens also remain unwatered when houses are vacated for holiday periods. Regular pruning of either the foliage or roots of the offending tree reduces the demand for soil water and so may arrest further cracking or distortion of the house. Deep root pruning can be achieved with a narrow trenching machine. Advice should be sought on the possible deleterious effects on the tree from regular hard pruning —some native trees can be irreparably damaged.

Underpinning of footings can prevent further tree damage if it is carried out to sufficient depth to avoid the drying influence of tree roots. Conventional underpinning with pads may often be impractical as the depth of drying is commonly greater than 1 m. A more preferable form of underpinning incorporates deep concrete piers or driven piles. Watering of the soil prior to any underpinning is recommended to close cracking as much as possible.

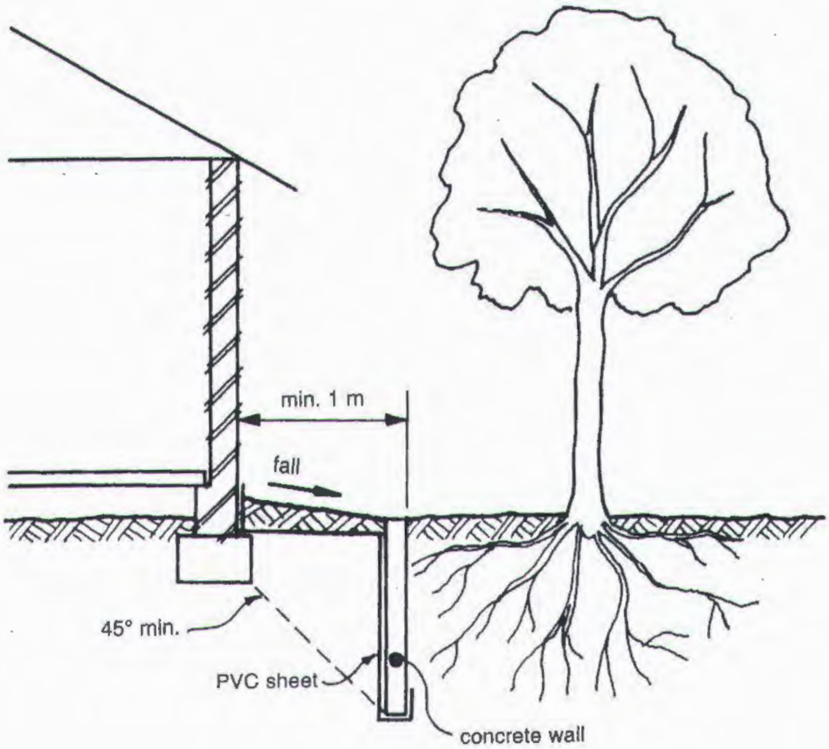
A further alternative is to construct a vertical cut-off wall between the trees and the damaged footings. Small trenching machines can dig narrow trenches to depths of 1.5 m or greater, which can then be filled with lightly reinforced concrete. Again, the depth of drying needs to be carefully estimated given the imposition of the wall on the site to ensure that roots will not develop beneath the wall and eventually undermine the treatment. A program of soil watering behind the wall is normally used in conjunction with its installation to accelerate soil moisture redistribution beneath the affected house.

## REPAIR METHODS




**Underpinning**




**Cut-off wall**

## SPECIES OF TREES TO AVOID

The trees listed below may be planted on a building block provided that the conditions for the site are deemed not to be conducive to shrinkage settlement, or the planting rules previously outlined are adhered to, or the footings are suitably stiffened, or cut-off walls are provided.

| *Botanical name* | *Common name* | *Mature height H (m)* |
|---|---|---|
| *Angophora costata* | Smooth barked apple | 15–24 |
| *Araucaria heterophylla* (and similar species) | Norfolk Island pine | 30–60 |
| *Casuarina cunninghamiana* | River sheoak | 12–30 |
| *Casuarina glauca* | Swamp sheoak | 12–15 |
| *Cedrus* species | Cedars | variable |
| *Cupressus* species | Cypress | variable |
| *Eucalyptus bridgesiana* | But-but | — |
| *Eucalyptus camaldulensis* | River red gum | 24–30 |
| *Eucalyptus citriodora* | Lemon-scented gum | to 15 |
| *Eucalyptus cladocalyx* | Sugar gum | 15–30 |
| *Eucalyptus cornuta* | Yate | 9–18 |
| *Eucalyptus diversicolor* | Karri | to 60 |
| *Eucalyptus globulus* | Tasmanian blue gum | 30–60 |
| *Eucalyptus leucoxylon* | Yellow gum | 4.5–7.5 |
| *Eucalyptus maculata* | Spotted gum | 18–30 |
| *Eucalyptus occidentalis* | Flat-topped yate | — |
| *Eucalyptus rubida* | Candlebark | 9–30 |
| *Eucalyptus viminalis* | Manna gum | 9–60 |
| *Ficus* species | Figs | to 30 |
| *Fraxinus oxycarpa* | Desert ash | 9–15 |
| *Fraxinus* 'Raywood' (unless grafted or budded onto a rootstock of *Fraxinus ornus* (Manna ash)) | Claret ash | 9–15 |
| *Grevillea robusta* | Southern silky oak | 15–30 |
| *Phoenix* species | Date palms | variable |
| *Populus nigra* (and similar species) | Black poplar | to 24 |
| *Quercus robur* (and similar species) | English oak | to 20 |
| *Robinia pseudoacacia* | False acacia, black locust | 9–15 |
| *Salix babylonica* (and similar species) | Weeping willow | 9–15 |
| *Salix chilensis* 'Fastigiata' | Chilean willow | — |
| *Schinus molle* | Pepper tree | 6–15 |
| *Tamaris aphylla* | Athel tree | to 6 |
| *Ulmus procera* (and similar species) | English elm | to 30 |

The information contained in this table has been derived from:


- Baker, P. D. 1978, *Tree Root Intrusion Into Sewers: Progress Report No. 2—Analysis of Root Chokes by Species*, Engineering and Water Supply Department of South Australia, Sewerage Branch, August.
- Lord, E. E. 1970, *Shrubs and Trees for Australian Gardens*, 4th Edn, Lothian Publishing Co., Australia.


### Suggested further reading


- Cameron, D. A. & Walsh, P. F. 1984, *Damage to Buildings on Clay Soils*, Technical Bulletin 5.1, Australian Council of National Trusts.


### Disclaimer


***The information in this and other Information Sheets is advisory, it is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject. Further professional advice might need to be obtained before taking any action based on the informaton provided.***