Tree Root Damage to Buildings

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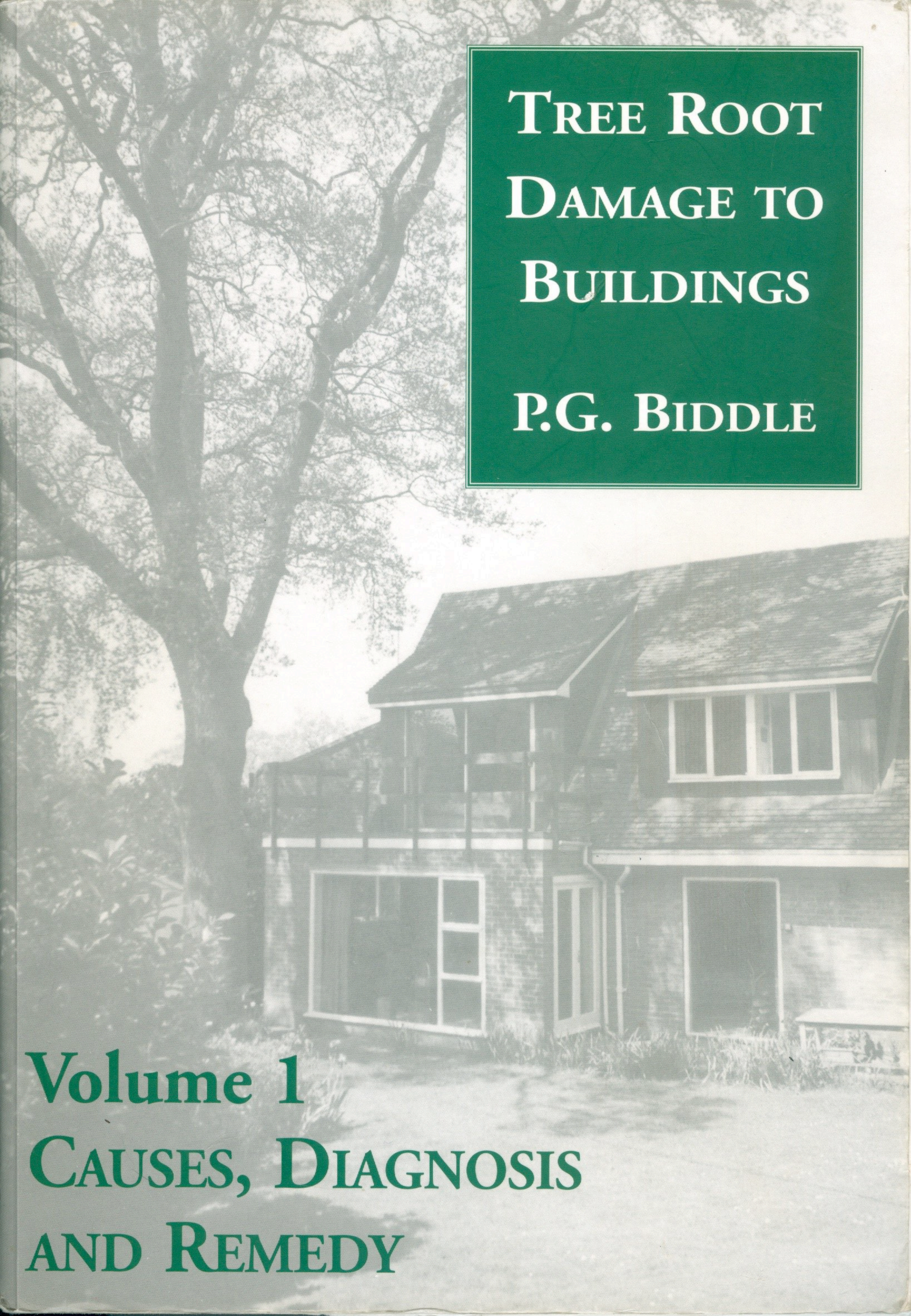

Volume 1

Causes, Diagnosis and Remedy

The need to support the weight of the aerial parts is similar to the function of a house foundation, requiring the load to be spread over a wide area. At the base of the trunk the tree sub-divides into large buttress roots which usually turn at right angles to the trunk to extend out radially, thereby spreading the load. These buttress roots need to be stiff, and for this reason they are very thick, and are usually either oval or figure-of-eight shaped in cross-section, as these shapes will be more effective for supporting the vertical load. Severance or damage to any of these roots can have serious implications for the stability of a tree.

Figure 3.7

Horizontally spreading structural roots of a mature beech exposed by erosion. These roots have probably increased abnormally in diameter as a result of their exposure.

As well as supporting the trunk, the large diameter buttress roots will provide some anchorage into the soil. However, efficient anchorage requires the tree to bind to a large volume of soil around the base of the trunk and for this purpose it is most effective to have a large number of small diameter roots which increase the surface contact with the surrounding soil. The root systems of most trees reflect these requirements, with the main buttress roots rapidly subdividing into a mass of smaller roots, so that even a large tree may have few roots in excess of 20mm diameter at a distance of 3m from the trunk (Figure 3.7). These roots are only subject to tensile forces directly along their length; they do not have to support the load of the trunk and so do not require lateral stiffening. For this reason they are pliant, but with high tensile strength (Figure 3.8). This strength can be of great value in soil stabilisation.

Hardwoods	Alder	32
	Birch	37
	False acacia	68
	Hybrid poplar	32-46
	Oak	32
	Willow	36
	Sallow	11
Conifers	Douglas fir	19-61
	Monterey pine	18
	Sitka spruce	23

Figure 3.8

Tensile strength of roots (MN/m²).

(from Coppin and Richards, 1990)

All of these roots combine to anchor the tree into the soil. The mass of roots and surrounding soil is normally referred to as the root plate, and it is this which is exposed if a tree is up-rooted. Observation on uprooted trees, especially following the Great Storm of October 1987, has provided extensive data on the shape of the roots within the root plate. A questionnaire sent out by Task Force Trees after this storm defined 6 main shapes of root system. Figure 3.9 shows these shapes and the relative frequency of the responses (Cutler *et al.* 1990). Many of the roots described as laterals would probably have been described as laterals with droppers if greater portions had been examined. This survey confirmed the rarity of tap roots, which were only found in 2% of the sample. A more detailed appraisal of the shape of the root plate of different species is provided by Gasson and Cutler (1990), although it must again be emphasised that root plate morphology, like all other parts of the root system, is influenced more by the environmental conditions than by the differences between species.

This survey also emphasized how shallow the roots are, even within the root plate directly beneath the trunk. In 50% of cases the depth of the plate was less than 1.0m, with it exceeding 2.0m in less than 4% of cases. Depths were especially shallow over chalk soils.

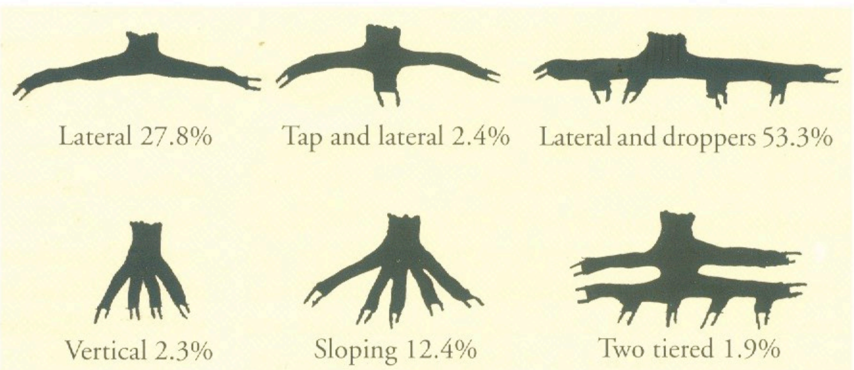

Figure 3.9

The distinction in previous sections between the fine, conducting and structural roots might imply that the sole function of these types of root are for water absorption, conduction and for anchoring the tree respectively. In practice all these roots are binding to the soil and helping to anchor the tree, regardless of their size.

Although there is a margin of safety against failure, damage to roots within the root plate area, either from natural causes such as decay or from severance by man, can affect the stability of a tree.

Root mortality

At all stages in root development, there is a high mortality (Head, 1965). The short lateral roots may only live a few weeks, and at most for a single season. Similarly, the majority of extension roots do not develop secondary thickening but die within one or two years. Most of this root death occurs in the winter, when the aerial parts are dormant. For instance, it was estimated (Bode, 1959) that 90% of the absorbing roots of walnut died during the winter. This shedding of roots can be considered analogous to the annual leaf drop. It is known from studies on fruit trees that the extent and timing of root death can be very variable, but there is very little information on amenity trees.

The greatest mortality occurs in the fine lateral and extension roots, but roots of any size are liable to die. For instance, a young tree seedling will have many lateral supporting roots, but by the time the tree matures, this has been reduced to only a few main laterals.

It must therefore be recognised that the root system is dynamic, with a mass of new roots being produced, living for variable times and growing to varying extent before they die. The root system is not immutable, but will respond to changing conditions.

Root regeneration

In most cases roots which are severed will regenerate. The severed root may dieback by a few centimetres, but new roots will be initiated from the cambial layer near the end of the root, producing a 'bottle-brush' appearance (Figure 3.10). These regenerated roots can grow rapidly to re-exploit the soil volume previously occupied by the severed root. There is probably considerable variation between species and individuals in their ability to regenerate, but there is inadequate data on the scope of this variation. It is known that the root system of a vigorous young tree, with good starch reserves, will regenerate more readily.

Figure 3.10

Regeneration of roots from a severed structural root.

The root as a storage organ

The roots of all perennial plants are used for storage, with parts of the roots of some plants, such as sugar beet or potato, specialised as storage organs. During the summer, sugar from the leaves is conducted in the phloem down to the roots, where it is polymerised into starch for storage. The cells throughout the xylem tissue of the roots are filled with starch grains, the concentration typically reaching a maximum in late summer. In trees, all of the perennial roots, i.e. the conducting and structural roots, are used for this purpose.

During the winter the reserves are slightly depleted, but the main use is in the spring when the starch is reconverted to sugar and then used for the initial burst of growth, while the leaves flush and new wood tissue is laid down by the cambium. The sugar moves up in the vessels from the roots to the leaves and cambial cells as a dilute syrupy solution. This sap can be tapped in trees such as maple to make maple syrup. The surge of spring growth will reduce the reserves, but these are again replenished in the summer.

A vigorous tree will maintain high reserves, but if a tree goes under stress for any reason it will utilise and deplete the reserves. In a reasonably vigorous tree the reserves are sufficient to maintain the root system and the first flush of growth for about a year. For this reason, if a tree is ring-barked so as to destroy the phloem connection down to the roots, the roots can carry on functioning and absorbing water until the reserves are exhausted. Thereafter the root system will die.