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TREE ROOT DAMAGES TO INFRASTRUCTURE STUDY COMMISSIONED BY WESTPOOL GROUP NSW*

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Quote: *"We have been conditioned to blame tree roots for a host of engineering and design failures. Among the scientific community as other questions are being examined under replicated and controlled conditions, we accept a biased view of cause and effect and often blame tree roots based on circumstantial evidence. Roots are not primary causal agents of damage within infrastructures and engineered resource control solutions."*
Dr K.D. Coder, Associate Professor of Forest Resources, School of Forest Resources, University of Georgia, Athens, GA30602 USA. (1998)

Tree Root Growth

There are two main types of tree roots:

- Tiny fibrous roots
- Older suberized roots

Tree roots 'grow' in two dimensions:

- radial growth or root enlargement
- axial growth or root elongation

Root Enlargement

Radial root growth enlarges the root whereas axial root growth lengthens the root. Root enlargement may create a lifting pressure (like a jack) to displace and dislodge lightweight pavers. IF squashed against a fragile rigid pipe (eg clay pipe or thin concrete pipe) the radial expansion pressure of the older root could cause the pipe to fracture, thus allowing tiny fibrous roots to enter the hairline crack. Once entered the cracked pipe, the fibrous roots grow over time to form a thick mat of tree roots. In addition tiny soil silt particles can enter the cracked pipe and combine with the fine roots to cause flow-blockage in the pipe.

The fragile rigid clay or concrete pipe may also be cracked by digging, excavation, ground vibration, earth tremor and soil movement. Faulty plumbing joints may also

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present entry points to fine tree roots. Pre-existing cracks in pipes are the only possible entry points for roots to intrude, because tree roots are unable to exert an axial growth pressure high enough to force entry into an intact crack-free pipe.

Root Elongation

Tree roots elongate and grow to great horizontal distances, and have been reported to grow as far (in a totally unimpeded soil medium) as three times the tree height. But tree roots rarely grow deep – in fact a major proportion (90%) of tree roots is confined in the top 2m of the topsoil profile. Imagine a tree 30m tall – the root plate could be 90m radius and yet only 2m deep! This is in contrast to the old way of thinking about the 'root ball' growing only as far as the canopy drip line but as deep as the tree height.

Tree Root Zone

The tree root zone is generally a space with a depth of between 1.5m to 2m and may extend laterally to a distance some three times the tree-canopy drip-line or tree height. Gasson & Cutler (1990)[1] found that 81% of all tree roots examined were less than 1.5m deep, and up to 95% of all tree roots were less than 2m deep. It has also been reported that where there was high rainfall and compacted soil or poor drainage, roots might be extremely shallow and no deeper than a few centimetres. How far roots go laterally correlates with factors such as tree height, trunk diameter or crown radius. Gilman et al. (1987) found that tree roots can extend laterally up to three times as far from the trunk as the tree branches (except for those trees with special crown shapes eg narrow fastigiate crowns) whereas Gasson & Cutler (1990)[2] found that 35% of all wind-thrown trees examined had root-plates of 1-2 metre radii and 50% of <0.5 to 1 metre radii only. From these figures we know that the bulk of the tree roots exist only in a fairly shallow soil layer to a distance of up to three times the crown radius.

Sewers normally are laid at a depth considerably below ground level, hence out of range for most tree roots to tap into. However if the sewer has a breakage, and the leaking outflow creates a fertile and moist pathway to facilitate tree root growth, then root entry and blockage could occur.

Factors limiting root growth

Roots elongate by penetrating through soil particles. The larger the pore size between the soil particles, the more penetrable is the soil, and the easier it is for tree roots to grow into. It is more difficult for tree roots to penetrate compacted soils. Dry soil is much harder than wet soil, and offers greater resistance to root elongation.

For roots to grow and penetrate through soil, the root must generate an internal growth pressure at the root tip greater than the external soil strength. Tree roots can increase their internal growth pressure (turgor) when they encounter a compacted soil by adjusting the water (osmotic) pressure in the cell sap. The highest root axial growth pressure measured and published in scientific journals did not exceed 1.5MPa (1MPa=1000KPa). Therefore if a root encounters an object such as a rock, a kerbstone, an intact pipe or

compacted soil, the root firstly pumps up its internal turgor up to but not exceeding 1.5MPa in an attempt to push through, failing that the root gives up its attempt to penetrate, and it will grow along an easier path of lower resistance, such as the side of the kerbstone or the outer surface of an intact pipe.

Rate of Root Elongation

The rate of root elongation depends on many external factors – availability of soil water and soil nutrients, soil aeration, soil temperature, and soil strength. Figures published in USA (Watson 1993) suggest that in the cooler temperate regions new roots elongate at a rate of about 30-60 cm/yr whereas in the warmer tropical states roots elongate between 60-110 cm/yr. Live Oak roots in Florida have been reported to grow at a rate of 300 cm/yr! Corresponding figures in Australia for native trees are not available for comparison.

Factors Limiting Tree Root Growth

Contrary to common belief, tree root growth is governed more by soil conditions than to individual tree species.

The soil physical factors which restrict root growth include:

- low soil water content θ (low root growth turgor pressure P_t)
- low soil aeration (restricts aerobic respiration in tree roots)
- high soil strength $\mathbf{q_p}$ (low net growth pressure $P_t - q_p$)

Roots Searching for Soil Moisture

Tree roots do **not** grow in search of distant sources of water. Roots cannot grow in dry soil because they can only grow where water is present. Roots do not have remote-sensing mechanism to detect where the nearest water source is and certainly tree roots do not engage in destroy missions to bust intact pipes in order to get water. Tree roots cannot force entry into well constructed, properly sealed, fracture-free plastic pipelines with adequate flexibility.

References:

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