



# Sydney Environmental & Soil Laboratory

Specialists in Soil Chemistry, Agronomy  
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## Trees and Traffic

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## Trees and Traffic

### Question:

What can we do to improve the root volume of city street trees squeezed in between roads, pavements and underground installations and how do we prevent roots from damaging structures and lifting paving?

### Answer:

There is a fundamental conflict between the landscape soil scientist and the engineer (Craul 1992 pg 212). The engineer treats soil as a structural material required to take the bearing loads of pedestrians, buildings, and roadways and wants to see it heavily consolidated to the required strength, air and water excluded, and roots of trees confined in narrow planting pits restrained by root barriers to prevent heaving of the new pavements. The landscape soil scientist wants a loose, well aerated, moist, and uncompacted rooting volume as large as possible to ensure longevity and good performance of the tree.

Understandably, for safety and cost reasons, the engineer usually has his way and a rooting volume far less than is required for maturity of the tree to be reached is left for the landscape people to work with. I was involved in a study of tree roots in urban street scapes and we showed that the trees in this situation (see photo) had virtually no structural roots. The only feeder roots the plants had were entering the sandy backfill of installations such as telephone cables, just what the engineers did not want!

A number of solutions to this situation are used.

- 1. Choice of plant material.** The commonest way around the problem is to try to choose plant material known to tolerate minute rooting volumes, poor aeration, drought, and waterlogging. *Celtis*, *Platanus*, *Lophostemon* and *Populus* are common selections where tough urban soil conditions prevail. This can result in rather monotonous city plantings and the general landscape concept can be compromised. Even these selections will give poor results in difficult situations and remain stunted and sickly.
- 2. Use of planting vaults.** In this approach, a planting pit, confined by concrete or root barriers is engineered with a capping of suspended concrete slab to take the pressure of traffic and compaction. A deep box like planter is not in keeping with the natural distribution of plant roots which spread shallow and widely in a normal soil. To admit air at depth and overcome this problem various aeration pipes and gravel layers are used. The root volume is still highly confined, the plant is dependant on continuity of irrigation, and the suspended slab and vault are very expensive to construct. Nevertheless this highly engineered situation works well if aeration is considered although rooting volume is seldom sufficient.
- 3. Gap graded or "structural soils".** This latest approach is gaining ground rapidly.

In this approach, which has been evolving in Europe and the USA for some years now, an engineered "soil" which can be compacted to take tremendous weight bearing loads while allowing large voids to remain for root extension, air and water movement, is designed. The engineered soil can be used right under the roadway and footpaths to take the weight of heavy vehicle transports and constant pedestrian traffic (both of which apply about the same pressure to the soil surface) as well as providing a very large exploitable root volume similar to that available in a natural environment. The roots eventually fill the large voids without creating heaving, and the needs of the engineer and the landscaper are met in the one soil specification. The key paper in this area is that of Grabosky and Bassuk (1995) but being relatively new it does not appear in any of the standard texts as yet.

The general principle of these "structural soils" as they have been called, are that a large gap graded (no fines) gravel aggregate is mixed with a horticultural "filler soil". The gravel will take

the weight bearing through point to point contact (See Fig 1), and the filler soil will provide for the needs of the tree. The type, size and shape of the aggregate, amount of filler soil to add, type of filler soil, and need for additional aeration must all be considered.

A gravel must be chosen which has a high strength, and high resistance to weathering and must be easily compactable. The size of gravel dictates the size of roots which can grow in the void space, generally, the pore diameter can be assumed to be 1/5<sup>th</sup> of the particle diameter. Thus a 40 mm aggregate will admit roots up to 8mm diameter without heaving.

The shape of the gravel dictates how easily it can be compacted. A round particle compacts easily and quickly, a flattish particle is difficult to compact and when compacted gives small void diameters. Total pore space ratios of 35 to 43% occur depending on particle shape (round shapes pack well and give the lowest void ratios).

The geology of the gravel dictates its strength and weathering rate. We do not want a weak stone which may break down during compaction and weather in a short time. Granite and basalt aggregates provide the highest strength and are available in a range of gap graded sizes.

Having established the total pore volume of the fully compacted aggregate, the amount and type of filler soil to add must be considered. The more soil you add, the more difficult it is to obtain maximal compaction. The literature suggests filling the voids to 95 to 100% of the total pore volume with a sandy loam soil. We believe that this must be considered carefully as filling 100% of the total pore space may defeat the purpose of avoiding heaving and admitting air deep in the profile, and the use of a very sandy soil may not bring sufficient benefits to water holding and nutrient holding ability which depends on a reasonable cation exchange capacity and the presence of some organic matter.

This structural soil approach possibly represents the most scientifically credible and cost effective way to provide for the needs of the engineer and the tree and to bring larger rooting volumes and hence improved longevity to the urban street tree while reducing the incidence of heaving and damage to structures. Too good to be true? Some exciting and innovative structural soil trials are being performed at the Homebush Olympics site and the results will be published soon for us all to assess. So far the results look very promising.

### **Further Reading**

Craul P.J. 1992. *Urban Soil in Landscape Design*. John Wiley & Sons New York . pg 59 and pp 165...166.

Grabosky, J. and N. Bassuk 1995. A New Urban Street Tree Soil to Safely Increase Rooting Volumes under Sidewalks. *Jnl Arboriculture* 21(4): July 1995.

Harris, R.W. 1983. *Arboriculture. Care of Trees, Shrubs, and Vines in the Landscape*. Prentice Hall, INC. New Jersey.