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CONSTRUCTING ROOT SPACE FOR TREES IN AUSTRALIAN CITIES

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Abstract: Over the last 6 years Brisbane's central business district has grown significantly greener and more pedestrian friendly, using a combination of "tree trench" technology and footpath widening. Millions of spectators at the Olympic Games in Sydney in 2000, walked along boulevards lined with fig trees and jacarandas growing in tree trenches covered with porous paving. Incorporating tree trenches beneath pavements in both site upgrades and new projects, is an exciting and cost effective approach to greening urban centres.

INTRODUCTION

Those parts of our towns and cities covered with impervious pavements like car parks, footpaths, and malls, are usually the most "tree hungry" sites. Trees in paved areas provide relief from the surrounding built forms, and they shade, cool and beautify these locations. Yet paved sites present unique challenges to planting and growing new trees, as well as preserving existing trees. The typical street tree planting space, which is inhospitably sandwiched in a narrow strip between the road and footpath, places severe limitations upon healthy tree growth and development. Impervious pavements exacerbate the already disturbed, deoxygenated and contaminated soil conditions by requiring surface compaction of these small spaces (Craul, 1985). Without providing adequate space, of suitable quality, for tree root growth, new trees can not grow to their full potential, and therefore are more likely to cause damage to surrounding pavements, require more maintenance, deliver less benefits and die earlier.

Recent research in the United States has developed a stone-soil media ("structural soil") for tree planting sites where the stone matrix bears the load of compaction required for paving while the spaces between the stones provide an uncompacted voids for soil media and root growth (Grabosky & Bassuk, 1995,1996). When added to excavated spaces under pavements, "structural soils" provide "tree trenches" where roots have access to a much greater volume of suitable growing space than conventional planting holes. "Amsterdam tree soil" (Couenberg, 1994) is another type of gap-graded matrix which has been used to enhance tree performance in Europe for 30 years.

This paper describes the application of "structural soil" technology and other "tree trench" designs in Australian cities.

GREENING CITY CENTRES

Since Grabosky & Bassuk's publication, several city centre projects in Brisbane, Sydney, Melbourne, and Hobart have incorporated "tree trenches" into major streetscape improvement projects where large growing tree species were an important part of the desired outcomes.

In 1995 Brisbane City Council initiated a City Signature Program which reclaimed 2 lanes of roadside carparking along 6 blocks of a central city street and converted that space into a pedestrian friendly tree lined boulevard. A key justification to look beyond conventional tree planting holes in the pavement was introduced early in the design phase when concept plans began to show an avenue of large upright trees humanising the scale of the surrounding high rise buildings, shading wide pavement areas and framing a view from the heart of the city through to the City Botanic Gardens (Figure 1). Two important pieces of information were introduced to the design team. Firstly, to grow a 10m tall, 6m wide dense canopied tree to meet the design intent would require at least 8.3 cubic metres of soil volume for root growth which needed to be rewet to 20% water holding capacity every 4 days and have no less than 20% air-filled porosity (Lindsey & Bassuk, 1991). Secondly, core samples along the proposed tree line revealed that the site soil consisted of a 200-300mm layer of fill, overlaying a plastic alluvial clay with high moisture content. It was obvious that existing site conditions were not going to support the desired species within a standard 1.5 cubic metre planting hole. The decision to install tree trenches was also helped by the need to excavate to relocate existing underground services along the new road edge. Additional excavation for the tree trench, therefore, did not add significantly to the construction costs. It must be emphasised that assessments of existing soil conditions and estimates of soil quantities and qualities required to support desired tree growth are vital to designing spaces for large growing trees.

Structural soil tree trenches in the first two City Signature projects in Brisbane used 200mm bluestone as the structural component and a composite loam soil media as the backfill for the voids between the bluestone. These large stone mixes have also been used in Brisbane’s Roma St Parklands project and Grey St Boulevard.

The structural soil trench incorporated into the tree lined entrance to Stadium Australia at the Sydney Olympic site used a smaller stone/gravel (45mm), and premixed the gravel with a filler soil of high cation exchange capacity (Leake, 2001 pers com). Care was taken to add only enough filler soil that would occupy 50% of the gravel voids. This premixed structural soil is now available as part of the product range of Benedict Soil and Gravel Pty Ltd in Sydney. This mix has also been used in city centre projects in Sydney, including some trials on improving root zones of existing street trees.

A third Brisbane city centre project used a different style of tree trench – a reinforced slab suspended between the back of the new kerb and the old footpath pavement. The slab supported the new footpath pavement and provided a tree trench which was completely filled with growing media (Figure 2). Capped access points midway between each tree site were provided to allow watering and fertilising. The void between the slab and the soil surface allowed aeration between each grated tree site. This suspended slab technique makes even more space available for root growth than structural soils, where the stone matrix occupies up to 60% of the tree trench volumes.

Although each of these projects are relatively young, early tree performance has been significantly better than street tree counterparts planted in small holes, and there have been no signs of pavement upheaval or subsidence.

MODIFYING BACKFILL IN SERVICE TRENCH EXCAVATIONS

Structural soil technology has also been used to provide better conditions for root growth within the backfill of a large service trench. A new 1.75m diameter water pipe had to be constructed close to a row of significant fig trees using open excavation style. A layer in the existing soil profile was found to support root growth, and it was therefore decided to replace that layer in the backfill soil using structural soil like a filling in a sandwich of fine gravel supporting the pipe and the new road surface. A premix of recycled concrete (80-100mm diameter) and clay/loam was used in at this site. Although it is always better to avoid root damage in the first place, providing suitable conditions for root regeneration is an important tool in preserving significant trees in urban landscapes.

SHADE TREE PLANTING IN CAR PARKS

Trees in car parks are given little opportunity to perform when planted in compacted subgrade and confined in small spaces surrounded by kerbing. Those trees which do better have usually escaped the kerbed space and have roots upheaving the surrounding pavement. Structural soils are being trialed as an alternative for half of the tree plantings in an 80 space car park to allow space for root growth under the pavement. This is a joint project between Brisbane City Council and a private construction company. Construction modifications were simple and included a slightly deeper excavation, drainage installation at that depth, and additional capped vertical pipes to allow watering at the edges of the tree trench. Although the results of these modifications can not be evaluated until at least another 3-4 growing seasons, there is a strong case for wider use of the technique in car park construction.

COST EFFECTIVENESS OF TREE TRENCHES

On a per tree basis, tree trench installation is much more costly than conventional street tree planting in a paved footpath. However, when costs of poor tree performance, higher maintenance of both tree and pavement, tree replacement and loss of amenity values are considered, there is little doubt that tree trench installations provide a cost effective alternative. Such installations are often a very small part of overall costs for large scale construction projects. In locations like car parks, where only slight changes are made to the existing construction processes, installations of alternative, tree root friendly pavement subgrades adds little cost.

OPPORTUNITES FOR IMPROVEMENT OF TREE TRENCHES

Each new project in Australian cities has offered the opportunity to improve tree trench techniques, often because each site has its own unique constraints. Experiences so far have highlighted the need to further investigate the quality and quantity of filler soils. Managing the ongoing moisture, aeration and nutritional requirements of these man-made root zone spaces is also a challenge.

CONCLUSION

There is no doubt that the use of tree trench technology in high profile projects, especially the Sydney Olympic site, has increased interest in and application of such techniques in Australia. This has helped to further improve techniques, encourage discussion between arborists, engineers, soil scientists, landscape architects and project managers, and broaden the application beyond high budget projects. The use of structural soil as an alternative to conventional road base materials in car parks is one of the most exciting low cost applications of this technique.

However, tree trench techniques is but one of many tools to help achieve a better balance between infrastructure and tree cover in highly urbanised environments. It is a man-made root zone that has limitations. Options such as choosing species to match site conditions, or small scale site changes such as drainage installation, or site-soil chemistry adjustment should always be considered before more complex modifications such as underground tree trenches and extensive pavement coverings.

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