Wider application

There is a growing recognition of the benefits which come from growing tree canopies over paved areas, but tree roots cannot grow in traditional compacted pavement sub-base materials. In these situations they are not able to extend beyond the tree pit and may also suffer from waterlogging. The use of structural soils around the tree pit can overcome these problems, whilst still achieving satisfactory engineering standards for the prevention of subsidence.

Further information

National Urban Forestry Unit

This leaflet is one of a series produced by the National Urban Forestry Unit. NUFU provides a national focus for the exchange of information and good practice in urban forestry.

If you would like further information, or if you have examples of good practice to share with others, please contact:

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Further reading

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Urban Forestry in Practice

Load bearing soils for trees in paved areas

CASE STUDY24

Load bearing soils for trees in paved areas

Introduction

Newly planted street trees often show very poor survival and growth rates. A major reason for this is the restricted size of the planting pit and the compaction of surrounding soils. This seriously confines root growth. In order to achieve its full size, longevity and structural stability, the tree must be allowed to spread its roots into sufficient soil (rooting volume) to obtain adequate water, nutrients and minerals and to provide the necessary anchorage. Specially formulated soils that can be compacted enough to satisfy engineering standards, yet still allow root penetration, have been developed in the USA and mainland Europe over the last decade, but so far they have been rarely used in the UK.

Specific example

Project name and location

LOAD BEARING TREE SOILS, COPENHAGEN, DENMARK

Project partners

- Danish Forest and Landscape Research Institute
- City of Copenhagen

Project objectives

- To develop a pavement sub-base soil that can be compacted, yet allow root growth
- To determine the best method of sub-base soil placement

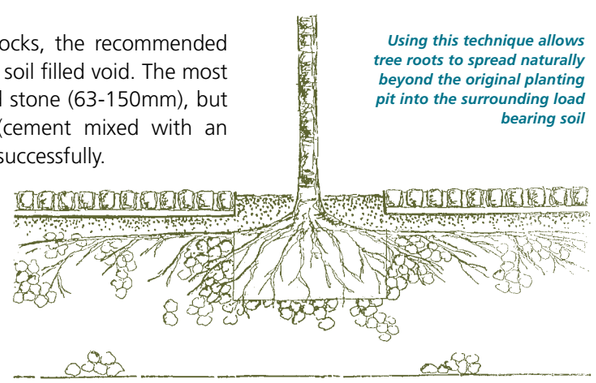
Method

The traditional method of establishing urban trees in Denmark has been to plant them in individual planting pits ranging in size from 0.8m^3 to 8.1m^3 (average 2.4m^3). However, it has been shown that the root of a tree with a canopy of 10m diameter needs 35-40m^2 of rooting soil. Tree roots therefore need to be able to penetrate the pavement sub-base. One successful technique for delivering this involves planting into a load bearing mix of stones and soil. This is recommended for use under traffic-free pedestrian areas, cycle paths, car parks and other areas where there are no trucks or heavy traffic. It is important to provide good drainage, as with any other urban planting.

The pavement sub-base is constructed using the structural soil/rock matrix. Extending this root-penetrable construction from one tree pit to the next allows continuous root spread. The rocks form the load-bearing element of the soil and they can be compacted so that they do not settle, whilst the soil, which provides the tree with moisture, minerals and nutrients, is located in the voids between the rocks. The proportion of the two elements is important. Too much soil and the rock matrix will not interlock, and when subjected to pressure the soil in-between will also be compacted. Too little soil and this fine material will settle out to leave air spaces in the voids.

Using approximately brick to half brick-sized rocks, the recommended ratio of rocks to soil is around 4:1 giving a 20% soil filled void. The most popular load-bearing matrix material is quarried stone (63-150mm), but crushed bricks, lava slag and *leca* concrete (cement mixed with an expanded clay aggregate) have also been used successfully.

The tree pit itself is filled with uncompacted topsoil, of the same type used in the soil/rock mix. This is important in order to minimise barrier zones between different soil textures.



Using this technique allows tree roots to spread naturally beyond the original planting pit into the surrounding load bearing soil

Implementation

At each planting site, the largest possible area is excavated to a depth of 0.6m, avoiding services and other obstructions. A temporary wire-mesh retaining hoop is positioned where the tree is to be located and filled with topsoil to ground level. This will form the planting pit. The structural soil is then placed around the tree pit and compacted to the desired density before the surface paving / tarmac is laid. The retaining hoop may then be removed and the standard tree planted.

The aggregate and soil can be pre-mixed before spreading. Alternatively, soil can be added to the aggregate at the surface and shaken, brushed or watered into the voids.

Three methods of placing and compacting this load-bearing soil have been developed. Each has advantages and disadvantages.

- **Premixing of soils and stones.** This mixture must be installed and compacted in layers of no more than 150-200mm, in order to achieve good compaction. Separation during transportation may be a problem. Also, there is a risk of de-mixing when the rock/soil mixture is transferred to the pit. The mix can be created on site using a front-end loader. Sometimes it may be beneficial to add a little water to the mix to help 'glue' the soil and the rock together. Smaller rocks tend to be better premixed with soil than larger rocks.

- **Water mixing during installation.** 150 - 250mm layers of stones are installed and compacted. Screened soil (e.g. a sandy loam) is spread on top of the stones and watered into the voids. The advantage with this method is that the soil remains uncompacted in the voids between the rocks. The main disadvantage is that the soil may separate and settle in layers within the mix. However, this problem has never been significant in the Danish cases. In general, large rocks are the most suitable for this type of installation technique.

- **Dry mixing during installation.** Stones are installed in layers to a depth of 150-250mm and the voids filled with dry soil by sweeping and vibration. The soil and stones need to be completely dry and this method is not suitable for stones less than 80mm in diameter.

Results

In Denmark, thousands of trees have been successfully planted since the early 1990s using these methods. Consistency of stone size is very important for the load-bearing matrix to prevent problems of compaction or soil voids. No difficulties with local load bearing capacities or *frost heave* of pavements have been recorded. Tree survival and growth rates have been as good as those for standard trees planted in uncompacted topsoil.