Research Technical Note
Urban Greenery Series
RTN
01-2014
January

Structural Soil – A solution for tree planting in constrained spaces

Author: Genevieve Ow

Introduction

Structural soil (**Fig. 1**) was developed in the United States by Cornell University and can be compacted to meet engineering requirements for paved surfaces, yet possessing qualities that allow roots to grow freely, under and away from the pavement. Structural soils are comprised of aggregate, clay loam, and are generally characterized for their load bearing capacity as well as horticultural properties. The substrate can be compacted to withstand pavement loads while permitting root growth. The matrix is comprised of a rigid load-bearing network of aggregate and soil where the soil will fill the macropores formed between the aggregate. This will provide an integrated, root penetrable, high strength pavement system that will expand the growing space of trees beyond their individual tree pits.

In an urban setting, soil under the carriageways and pavements are highly compacted to meet load-bearing requirements and engineering standards. Such conditions prevent root growth as the high level of compaction makes it difficult for roots to penetrate and the constrained conditions that are highly prevalent in most urban environments are only capable of holding a small /limited volume of soil which has little moisture, nutrients and oxygen. Hence, the application of structural soil can potentially alleviate some of these challenges faced in most urban cities by ensuring that an adequate amount of water, nutrients and oxygen is made available to tree roots. Therefore, providing an ideal soil environment for healthy trees and, supporting pavement without the need to compromise on spaces above ground (**Fig. 2**). The additional root space that the structural soils provide is believed to encourage extensive root growth (away from the pavement and surface). Deeper roots will potentially lead to greater tree stability and alleviate the damage of infrastructure derived through heaving.

Objective

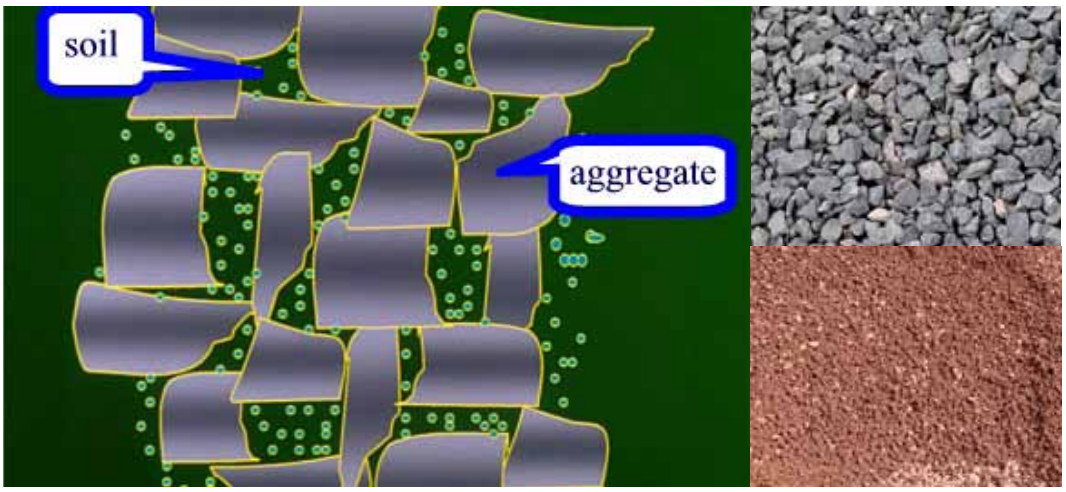

Fig 1. Conceptual illustration of structural soil (a mixture of aggregate and soil) used as a base course for pavement.

Structural soil is an urban engineering solution which benefits the arborist and the engineer and this technical note will highlight the pilot implementations currently underway to evaluate its potential and this substrate will also be compared against another urban solution known as the structural cells.

Riding on the positive results of a tree pulling experiment conducted in 2010, which showed that there was enhanced root growth and no negative effect on general growth performances of a tree when trees were grown in structural soils, the following site implementations were put in place.

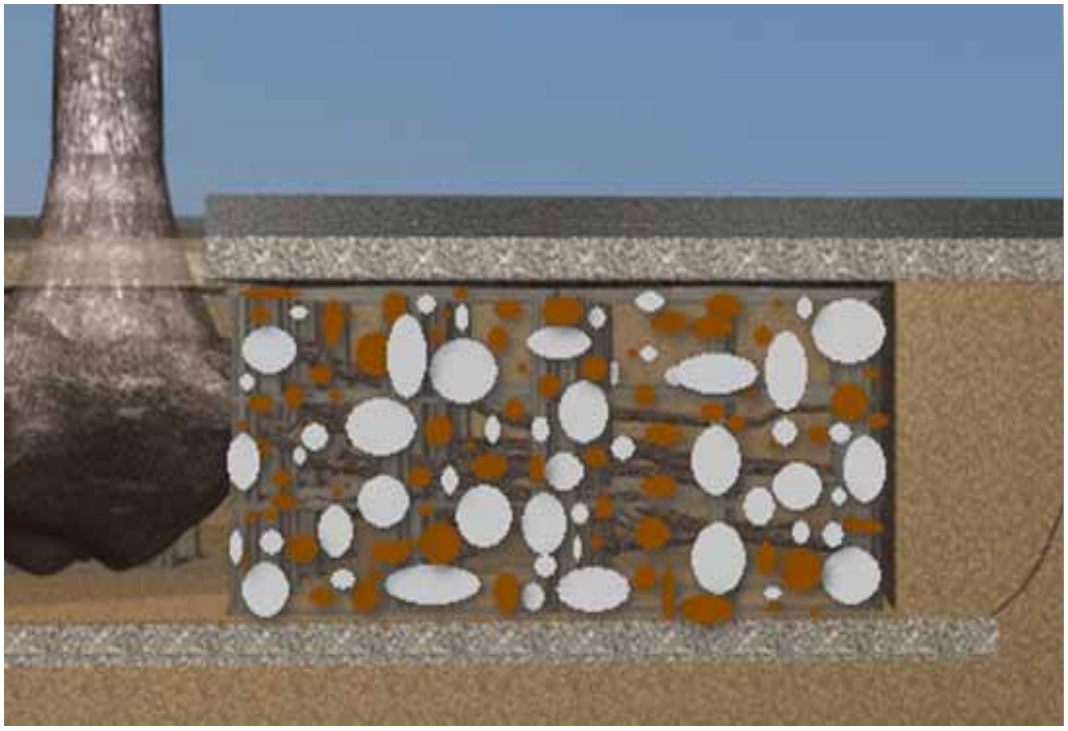

Fig 2. Structural soil enables tree roots to grow deeper, away from the surface and potentially alleviating problems of heaved surfaces.

Site Implementations

a. Pilot Implementation at Springleaf Park, installed in 2010

Fig 3. Setting up of tree pits at Springleaf Park to receive structural soil.

Structural soil was used here for the enlargement of tree pits and the extension of paved surfaces. Structural soil (**Fig. 3**) was extended beyond the constrained tree pits and was placed beneath the footpath allowing increased space and soil volume for roots to explore without having to compromise on pavement. These pits with structural soil have been compared with tree pits that have been filled with structural cells and control treatments containing NParks' approved soil mix (ASM) and the original soil found at the site.

b. Pilot Implementation along Pan Island Expressway (PIE), installed in 2011

Fig 4. Installation of structural soil along PIE.

Structural soil was installed along the centre median of the PIE between MacPherson and Geylang Bahru (**Fig. 4**). To facilitate road widening, the centre median was reduced to 1.5 m or less (in some areas) in width. The application of structural soil allowed for the extension of the planting verge beneath the carriageway where structural soil was used in place of the common sub base material to uphold the carriageway. In doing so, road widening was achieved without having to compromise on rooting space – roots are given the opportunity in this instance to explore the space beneath the carriageway (that has been filled with structural soil).

c. Pilot Implementation at Punggol (Car Park), installed in 2011

Fig 5. Load bearing tests conducted prior to the opening of the car park.

In this implementation, structural soil (**Fig. 5**) was used in the construction of a car park. This was compared against two other treatments which were compacted sub base (control) and structural cells. The site has been revisited to check for movement associated with surface/pavement settlement as well as cracking in the surface layer. These observations alongside physiological measurements have been monitored on a regular basis.

e. Pilot Implementation along Old Choa Chu Kang Road, installed in 2013

Fig 6. Installation of structural soil along Old Choa Chu Kang Road.

In the latest implementation, CUGE worked with LTA and Streetscape to implement structural soil beneath a carriageway. This was done to enhance the width and soil volume of a constrained planting verge brought about by road widening. This study will facilitate the evaluation of load bearing strength of the structural soil (**Fig. 6**) under dynamic conditions, on top of a long term evaluation of tree growth involving a mix which is made up predominantly of stone. This treatment will be compared against trees growing in structural cells as well as conditions of highly compacted aggregate (used as a control).

Pilot implementations– general findings to date

Regular monitoring of the above sites is ongoing and generally, the observations have been encouraging in terms of the aboveground growth conditions (of trees). Evaluations of belowground conditions (root zone) will be obtained through destructive harvesting in 2 to 5 years time depending on site and time of installation. Loading capabilities of the structural soils have also shown positive results.

The application of engineering solutions such as the structural soil is picking up pace in urban cities where greenery and infrastructure must coexist (yet space is often limited). The application of structural soil will allow for greenery to be brought closer to infrastructure and this is achieved without the need to compromise on paved surfaces. It is a solution for both the engineer and the arborist.