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Structural Soil

Aggregate-based Growing Media

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Introduction

Tree Establishment

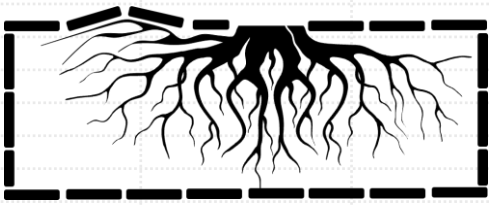
The major impediment to establishing trees in paved urban areas is the lack of adequate void spaces and soil for tree root growth.

Urban trees face a range of environmental challenges, such as exposure to pollutants, high temperatures, extreme drought or inundation, and limited space above- and below-ground. Yet the most significant problem that urban trees face is the scarcity of soil suitable for root growth.

A tree's ability to thrive depends primarily on the availability of oxygen in its soil. A dense surface layer causes oxygen deficiency and carbon dioxide poisoning in tree roots.

Often, trees in urban areas are surrounded by paved surfaces, which prevent them from getting enough water. Paved surfaces are designed to divert rainwater towards stormwater management devices or drains and not into the ground.

Tree root distribution is highly dependent on location. Ideally, roots grow toward a good oxygen supply and enough space. There is a difference between the root systems of city trees and trees in natural environments where roots are generally found in the top layer of soil. Urban tree roots seek oxygen and water under hardened surfaces.



Confined tree pits with limited volume can cause trees to **develop poorly** and can result in **pavement heaving**. Roots also tend to enter the loose gravel around pipes, which can lead to drain blockages.

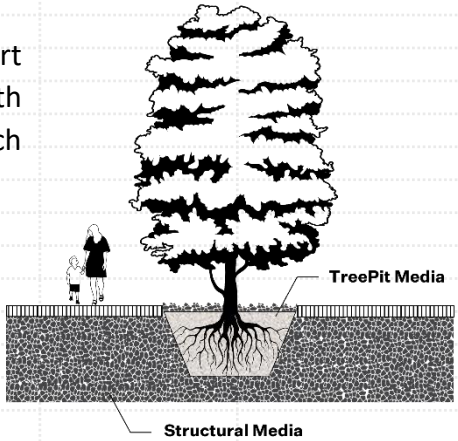
Structural Soil

Structural soil can meet engineering standards for supporting pedestrian and vehicular traffic while providing enough soil for a tree to grow and mature.

Structural soil is a stone-based growing medium that can support pedestrian and vehicular traffic. It enables tree pits to be extended beneath hard surfacing, providing enough soil for a tree to be healthy and reach maturity.

Structural Soil Benefits

- Root expansion beneath hard surfacing
- Uses rainwater to irrigate the urban trees
- Prevents surface rooting and sidewalk heaving up



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Blend Criticality

Structural soils are found all over the world in different types. Benchmark research has come from Cornell University in the USA, Stockholm in Europe and the City of Melbourne, which has informed performance guidelines in the development of the best solution for the New Zealand context.

Precise measurement and testing is required to meet desired outcomes; providing adequate void space for root growth, nutrient availability and aeration. Growing media is critical to project success. To get the media right requires research, experience and efficacious product sourcing.

NZ Media Considerations

Biochar Suitability: The main benefit of biochar is the ability to sequester nutrients inside the media, preventing nutrient loss. Understanding how initial feedstock properties and processing methods influence biochar characteristics is important and will significantly influence media performance. ScapeSpec have adopted the European standards for biochar selection to ensure ideal levels of heavy metals, particle size and nutrient holding capabilities.

Compost Suitability: Provides the necessary nutrients for plant/tree growth and health. The processing method effects the stability of the compost, if the carbon to nitrogen ratio is not optimal it can impact tree and root health. ScapeSpec follows the NZ S 4454:2005 to ensure product maturity.

Aggregate Suitability: Carefully chosen uniformly-graded stone, which allows healthy root growth and meets load-bearing specifications is required. It is important to not over-fill the voids which can compromise aeration. ScapeSpec sources aggregate which does not exceed acceptable dimensions.

Tree Support: The ScapeSpec Structural Zone blend (SZ120) includes TP120 which is a proven treepit media blend which has been installed in many thriving projects in the Auckland Region.

Mixing Technique: Blending consistent quality structural soil can be difficult due to weights and treatment of various components. The mixing process requires a stepwise additive procedure to ensure conformity. ScapeSpec has developed MixApp, a software solution that supports consistent and accurate blending (Appendix 1, page 9) .

Technical Specifications

Given the technical nature of the product it is imperative to obtain specific technical specifications and guarantee from suppliers of compliance to standards, with raw media meeting the parameters on page 5.

The technical specifications of three ScapeSpec structural soil alternatives are provided on pages 6 – 8.

- SZ120 includes TP120 (treepit soil) as a growing media and an added hydrogel agent.
- SH150 and SH060 use biochar and compost as growing media. SH150 has a larger aggregate size for different structure zones. Some guidelines suggest flushing the growing media through the aggregate and this is available on request.

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Raw Media Standards

The following limit values and declaration requirements must be observed.

Biochar

Parameter	Analysis	Maximum Acceptable Values*
Physical parameters	Particle Size < 3 mm	> 95%
Heavy Metals	Lead	120 g t^{-1} DM
	Cadmium	1.5 g t^{-1} DM
	Copper	100 g t^{-1} DM
	Nickel	50 g t^{-1} DM
	Zinc	400 g t^{-1} DM
	Arsenic	13 g t^{-1} DM
	Mercury	1 g t^{-1} DM
	Chromium	90 g t^{-1} DM
Nutrients	Nitrogen, Phosphorus, Iron, Potassium, Magnesium, Calcium	

*** EBC (2012-2022) 'European Biochar Certificate - Guidelines for a Sustainable Production of Biochar**

Compost

Parameter	Analysis	Maximum Acceptable Values*
Physical Parameters	Glass, metal and rigid plastics	0.5 (% dry matter w/w)
	Plastics–light and flexible or film	0.05 (% dry matter w/w)
	pH and Electrical Conductivity	
Heavy Metals	Lead	150 g t^{-1} DM
	Cadmium	1 g t^{-1} DM
	Copper	150 g t^{-1} DM
	Nickel	60 g t^{-1} DM
	Zinc	300 g t^{-1} DM
	Arsenic	20 g t^{-1} DM
	Mercury	1 g t^{-1} DM
	Chromium	90 g t^{-1} DM
Nutrients	Nitrogen, Phosphorus, Iron, Potassium, Magnesium, Calcium	
	C/N Ratio	< 20

*** NZ S 4454:2005 Compost Guideline**

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Specialists in engineered soils and bio-retention media

SZ120

Structural Zone is a stone-based growing medium that provides an integrated, root penetrable, high strength pavement system.

Structural Zone is a mixture of 40-60 mm clean stones and ScapeSpec Tree Pit media (TP120) which meets engineering requirements for a load-bearing paving base, while allowing tree pits to be extended beneath hard surfacing.

An organic hydrogel prevents the soil and stone from separating during the mixing and installation process. The compacted stone and soil mix has 20-30% void space for the storage and dispersal of air and water.

Tree Pit media (TP120)

TP120 is an engineered soil that supports tree maturity in urban environments. It is blended from quality sands, premium Waikato topsoil and rich compost. Working alongside Structural Zone, it has excellent workability. Slow releasing fertiliser can be added to give a good dose of nutrients and minerals to help tree root growth.

Our Performance

SZ120 has been engineered for performance. Stringent laboratory testing proves our mix to provide optimum root growing condition, supply adequate nutrients and oxygen, allow drainage, and support plant roots under international guidelines.

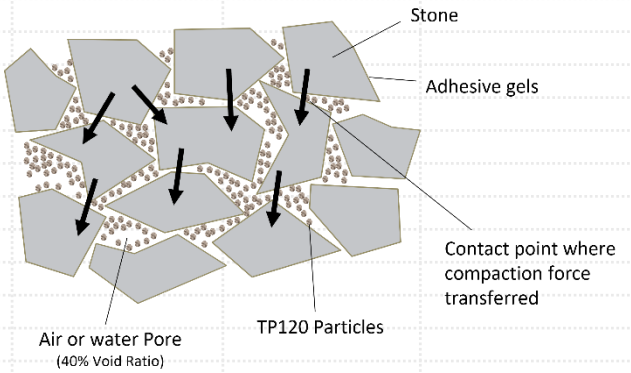
Structural Zone (SZ120) is designed meticulously with uniformly-graded stone and the proper stone-to-soil ratio. Acceptable aggregate dimensions will not exceed 2.5 to 1.0 for any two dimensions.

Importance of Design Criteria

A uniformly-graded stone with the proper stone-to-soil ratio creates a rich medium for healthy root growth, which can also be compacted to meet engineers' load-bearing requirements.

In the correct ratio, each stone touches another, forming a rigid lattice or skeleton, while soil almost fills the spaces between them. Aeration and bearing capacity are compromised if the voids are overfilled with soil.

As part of the mixing process, hydrogel is added as an adhesive gel to stabilise the mix. Stones and TP120 mix uniformly when the gel is applied, minimising separation caused by vibration in transit, dumping, and working the material during installation.



Aggregate Specification

Sieve Size (mm)	Percentage Passing (%)
63.0	100
53.0	80–100
37.5	0–10
2.5 : 1.0 Dimension Size	> 90%
Crushing Resistance	> 100 kN

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SH060

Growing stronger city trees with a carbon-negative, easy and natural method Stockholm stone-based growing medium supports root growth beneath hard surfacing.

Stockholm soil SH060 is made up of 40-60 mm clean stone combined with a 1:1 mix of enriched biochar and compost (15% volume). This method is well established and evaluated in Stockholm.

Biochar and Compost

Biochar improves composting performance, humification, microbial diversity and activity, reduces greenhouse gas emissions, and immobilizes potentially toxic metals and organic pollutants.

Biochar's porous structure also allows it to remove a wide range of pollutants from stormwater.

The pH profiles of biochar produced by different methods (pyrolysis or hydrothermal carbonization) and different feedstocks vary significantly.

Compost can hold more water with biochar which improves plant growth.

Biochar needs to be activated with the compost for a minimum of one month.

Full Blend Installation

All media is pre-blended and supplied for direct installation and compaction.

Biochar Specification

Total Nitrogen	0.20 %
Phosphorous	0.36 %
Potassium	1.37 %
Magnesium	0.55 %
Calcium	2.39 %
Iron	4,586 ppm
Zinc	168 ppm
Copper	34 ppm
Particles < 3 mm	> 95 %

Compost Specification

Total Nitrogen	1.75 %
Phosphorous	0.26 %
Potassium	1.27 %
Magnesium	0.30 %
Calcium	1.97 %
Iron	5,800 ppm
Lead	22 ppm
Cadmium	0.36 ppm
Copper	29 ppm
Nickel	4.4 ppm
Zinc	136 ppm
Arsenic	8.9 ppm
Mercury	< 0.12 ppm
Chromium	10.6 ppm
C/N Ratio	18.3

Aggregate Specification

Sieve Size (mm)	Percentage Passing (%)
63.0	100
53.0	80–100
37.5	0–10
2.5 : 1.0 Dimension Size	> 90%
Crushing Resistance	> 100 kN

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SH150

Stockholm soil is is a stone-based growing medium that supports pedestrian and vehicular traffic, allowing tree pits to extend beneath hard surfacing

Stockholm soil SH150 is made up of 90-150 mm clean stone combined with a 1:1 mix of enriched biochar and compost (15% volume). This method is well established and evaluated in Stockholm.

Stone must be a clean aggregate, angular to sub-angular in shape. This ensues optimal void space.

Biochar and Compost

Biochar improves composting performance, humification, microbial diversity and activity, reduces greenhouse gas emissions, and immobilizes potentially toxic metals and organic pollutants.

Biochar's porous structure also allows it to remove a wide range of pollutants from stormwater.

The pH profiles of biochar produced by different methods (pyrolysis or hydrothermal carbonization) and different feedstocks vary significantly.

Compost can hold more water with biochar which improves plant growth.

Biochar needs to be activated with the compost for a minimum of one month.

Optional Flush Install

Generally supplied as a fully blended media, the larger aggregate size SH150 does enable flush installation, where plant beds are laid out and packed in layers to achieve desired properties.

After a stone layer is laid and compacted, biochar and compost mix is flushed into the cavities with a strong jet of water.

Biochar Specification

Total Nitrogen	0.20 %
Phosphorous	0.36 %
Potassium	1.37 %
Magnesium	0.55 %
Calcium	2.39 %
Iron	4,586 ppm
Zinc	168 ppm
Copper	34 ppm
Particles < 3 mm	> 95 %

Compost Specification

Total Nitrogen	1.75 %
Phosphorous	0.26 %
Potassium	1.27 %
Magnesium	0.30 %
Calcium	1.97 %
Iron	5,800 ppm
Lead	22 ppm
Cadmium	0.36 ppm
Copper	29 ppm
Nickel	4.4 ppm
Zinc	136 ppm
Arsenic	8.9 ppm
Mercury	< 0.12 ppm
Chromium	10.6 ppm
C/N Ratio	18.3

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SH206

Aggregated based growing media for unpaved surfaces around urban trees

Growing media SH206 is made up of 2-7 mm aggregates combined with a 1:1 mix of enriched biochar and compost (25% volume) as growing medium around the urban trees (as a top layer of structural soil).

Biochar and Compost

Biochar improves composting performance, humification, microbial diversity and activity, reduces greenhouse gas emissions, and immobilizes potentially toxic metals and organic pollutants.

Biochar's porous structure also allows it to remove a wide range of pollutants from stormwater.

The pH profiles of biochar produced by different methods (pyrolysis or hydrothermal carbonization) and different feedstocks vary significantly.

Compost can hold more water with biochar which improves plant growth.

Biochar needs to be activated with the compost for a minimum of one month.

Full Blend Installation

All media is pre-blended and supplied for direct installation and compaction.

Biochar Specification

Total Nitrogen	0.20 %
Phosphorous	0.36 %
Potassium	1.37 %
Magnesium	0.55 %
Calcium	2.39 %
Iron	4,586 ppm
Zinc	168 ppm
Copper	34 ppm
Particles < 3 mm	> 95 %

Compost Specification

Total Nitrogen	1.75 %
Phosphorous	0.26 %
Potassium	1.27 %
Magnesium	0.30 %
Calcium	1.97 %
Iron	5,800 ppm
Lead	22 ppm
Cadmium	0.36 ppm
Copper	29 ppm
Nickel	4.4 ppm
Zinc	136 ppm
Arsenic	8.9 ppm
Mercury	< 0.12 ppm
Chromium	10.6 ppm
C/N Ratio	18.3

Aggregate Specification

Sieve Size (mm)	Percentage Passing (%)
8.00	100
6.30	95–100
2.36	< 1

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MixApp

Supporting consistent and accurate blends for industry confidence

MixApp is a data-driven production software specifically designed to support QA & QC standards for consistently high-quality batch blends.

Integrating mixing methodology with new to market technology, MixApp is an on-the-spot solution to support blend quality and accuracy. Guiding best practice mixing procedures backed by ongoing product testing - MixApp drives ease of blend without sacrificing product quality.

MixApp Benefits

Consistency

MixApp provides a foolproof process for media blending. Using precise metrics, the end user can have confidence that today's product will be the same as yesterday's.

Quality Assurance

Our QA driven process assures what is supplied meets specifications. MixApp assures the use of high-quality raw materials, sound mixing methodology and ongoing testing.

Ease of Blend

MixApp takes the guesswork out of high-quality batch blends. Access available mixes and materials, raw product weighing and loadouts on-site when you need.

Scheduled Testing

Instilling confidence, MixApp schedules ongoing product testing with unique codes for easy tracking of samples.

On Site

Available when and where you need it, MixApp provides up to the minute updates and is designed to work seamlessly on tablet.

Flexible

Whether mixing a pre-existing ScapeSpec blend or a bespoke blend created for you - these are easily loaded in and accessible in MixApp.

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