conventional construction for sidewalks in Stockholm a completely sealed surface where no water can be infiltrated or gas exchange can take place
More than 40 years on the site
Compaction of soil and dense surface layers is the main reason that trees do not grow in urban environments.

- **subgrade**
- sorted stone material 0-8, 0-16, 0-32, 0-63mm
- grain sizes between zero and upper grain fraction are included
KORNGRUPPSSKALA

Grus 6 ≤ 2 mm
Grov sand 2 ~ 0,6 mm
Mellan sand 0,6 ~ 0,2 mm
Nils 0,2 ~ 0,06 mm
Finne 0,06 ~ 0,02 mm
Nils 0,02 ~ 0,002 mm
Ler < 0,002 mm

Ler Nils Finne Mellan sand Grov sand Grus
soil profile with several layers of different materials
Compaction of soil and dense surface layer is the biggest reason that trees do not grow.
2000-5000 år
Toffelbacken
Compacted soil
Störd markprofil – infiltration som fungerar dåligt

- 55-70% ytvattenavrinning (för med sig föroreningar, näringsämnen och sediment)
- 15% ytvatten fördröjt eller infiltrerat
- 15-30% avdunstning
- 0% regnvatten fördröjt

Stockholms stad
Small stream
Bällstaån
Lokalt åtgärdsprogram

På väg mot god vattenstatus och anpassad för framtidens klimat

Åtgärdsbehov i Stockholms stod
Augusti 2017

action
program
Naturlig markprofil – fungerande infiltration

50% avdunstning

35% ytvatten fördröjt eller infilterat

15% ytvattensavrinning
Macadam is single-sized crushed stone
Using a loadbearing rock based growing substrate as a benefit for both for trees and stormwater management

Porosity around 40%
Inlets for Stormwater and gas exchange

1. Pavement
2. Geotextile
3. Layer of crushed rock for infiltration of surface water and airing of the soil
4. Structure of granite stones the space between is filled with soil
5. Terrace
6. Plant box of concrete
7. Tree
8. Planting soil
9. Catchment chamber for infiltration of surface water and airing the structural soil

Structural soil How to create good growing conditions and taking care of the rain
The contents of the terasse affect the capacity of infiltration.
Granit 90-150mm
Each layer 300 mm compacted for stability

Recycled concrete used as a part of the structural soil instead of granite
Slow release fertilizer

Layer for infiltration of rain water and aeration of the soil on top of the structural soil

Ventilation chamber and inlet of surface water

Flushing the soil into the structure
Important with geotextile connection against curbs inlets concrete boxes etc. so that no fine material could run into the airy base course.
• We take water from roofs and pavements through inlets to the ventilated bearing layer and the structural soil.

If the percolation layer is full, the storm water flows into the old street inlet.

• Roof and pavement surface 4600kvm Rainfall 600mm year (2 fot)
Approximately 2.3 million liters of water year Saved cost for the treatment of stormwater = 2300 euro /year
Reduced load on the Baltic Sea / and lakes at torrential rains
structural soil after 4 year

soil after 6 year
we find mykorrhitza in our structural soils which only thrives in good conditions (planting pits acting as a biological filter)
Odengatan first growing season
left 2002 right 2013  Kungsbroplan tree before and after structural soil
Recycled Concrete
Grusyta med trädplantering

70 mm Grusyta 50% 0-8 50% pimpsten 2-8
50 mm avjämningslager, 8-16 (4-16)

200 mm Luftigtbärlager 32-63

680 mm Skelettjord 90-150 jord typ D
Approximately 2,000 planting beds have been rebuilt with structural soil in the central parts of Stockholm.
Stockholm Biochar Project
Substitutes finite materials

Retains water and nutrients

Improves soil

Sequesters carbon

Biochar
Biochar and activated carbon filters for greywater treatment – comparison of organic matter and nutrients removal

Christina Berger
The world’s first urban carbon sink with biochar. This is how it works!

The energy becomes heat for the city’s district heating network within Open District Heating™

The biochar is used in the city plant beds

The Stockholmers get biochar to use in their gardens in exchange for their garden waste

Park and garden waste is turned into biochar and renewable energy

The city and the citizens create the world’s first urban carbon sink with biochar

Together we fight climate change and make our city greener
Pilotanläggningen
ÅVC Trädgård i Högdalen
Förnybar värme till 80 lägenheter
Biokol motsvarande CO2-utsläppen från 700 bilar

Projektets fullskala
Förnybar värme till 400 lägenheter
Biokol motsvarande CO2-utsläppen från 3500 bilar
About 500 000 tonnes of soil are sold every year in Stockholm made of Sand Clay and Peat that are finite resources.
Biochar and stone chips = crushed granite 3 parts (2-6 mm) and nutrient-enriched biochar 1 part.
Compost 1/8

Biochar 1/8

Macadam 6/8
Biochar and stone chips = crushed granite 6/8 volume (2-6mm) and nutrient-enriched biochar 1/8 volume
+ compost 1/8 volume
Biochar and stone chips = crushed granite (32-63 mm) and nutrient-enriched charcoal 15%. volume
indestructible soil which can take heavy loads without being destroyed
Different fractions we use

Macadam 2/6, 4/8, 8/11, 8/16, 11/16, 16/22, 16/32, 32/63, 32/90, 90/150

Grass

Vegetables

Perennials

Shrubs

Trees
Kolonivägen 2016
Magnolias, Cersis, Prunus.
1 part biochar 0-10mm och 3 parts macadam 4-8 mm 600mm.
Haukadalsgatan kolgrus
Magnus Ladulåsgatan Stockholm
Biochar with infiltration of stormwater

• Image # 1. Plant bed renovation a block of Magnus Ladulåsgatan where we follow our drawing ‘structural soil with biochar’.
• The stone and biochar, Concrete box where the tree is planted,
Structural soil with biochar

A method for building with stability and to create good growing conditions for trees in paved areas with the use of stormwater and the added value of decreasing the risk of roots damaging paving or underground pipes.

1. Paved surface with dished stormwater gutters
2. Geotextile
3. Leveling layer (crushed rock 8-18 mm) – also used for concrete bunker and water/air inlet.
4. Aerated bearing layer (crushed rock 32-63 mm)
5. Structural soil (crushed rock 100-150 mm) with fertilized biochar hosed into the structural volume
6. Pure biochar on terrace
7. Concrete bunker
8. Surface grid
9. Crushed rock with fertilized biochar
10. Inlet for air and water supply
Infiltrationsröra φ 110 (längd ca 4 m) förläggs i två riktningar från brunnen längs med växtbädden.

Lufthål placeras i höjd med luftigt bärlager

Beläggning/överbyggnad

Geotextil bruksklass N3

Avjämningslager
50 mm makadam
8–16 mm

Gångbana

Varierar

150–50

600

600 mm makadam 90–150 mm

Med näringsberikad biokol

Tätt plaströr φ 200

Makadam 8–16 mm

Brunnsbetäckning med sidointag

Körbana

Geotextil

Terrass

50 mm biokol (ogödslad)

Luckring av terrass 200 mm
Plant bed renovation a block of Nybrogatan where we follow our drawing ‘structural soil with biochar’. Some of the old trees were saved.

• The stone and biochar are mixed before the material is laid down, 15% by volume biochar.

• Closest to the roots of saved trees added a mixture of crushed granite and 25% manured biochar.

• Concrete box where the tree is planted, in it you can see macadam mixed with 15% biochar

**Nybrogatan Stockholm**

Biochar with infiltration of stormwater
STRUCTURAL SOIL WITH BIOCHAR

The City of Stockholm have set as a goal to create sustainable and durable plant beds from locally sourced materials. Structural soils with biochar binds carbon from the atmosphere and reduces leaching of nutrients.
Plant bed for street trees charcoal and macadam = crushed granite 32-63 mm mixed with 15% nutrient-enriched charcoal, granite can be replaced with recycled concrete with reinforcement (iron)
Nybrogatan 2016
Magnolia
Lingvägen
biochar with infiltration of stormwater

• Image # 1. Plant bed renovation a 600 meter by 2m wide and 1 m deep.
• Image # 2. where we follow our drawing ‘tree pit with slanting subgrade’
• Image # 3. The ditch filled with biochar and gravel 8-16mm and a few months after planting
Drawing showing how we build plant bed for trees in the green area along streets and roads to maximize infiltration of storm water through a charcoal filter in the bottom of the plant bed where we catch up nutrients and pollutants.

Charcoal stone chips = crushed granite (32-63 mm) and nutrient-enriched charcoal 10/1. volume. 850mm
Plant bed for street trees charcoal macadam = crushed granite 8-16 mm mixed with nutrient-enriched charcoal

Charcoalsoil
2-5 mm granit
depth 100 mm
Charcoalchips
8-16 mm granit
depth 900 mm
Compacted soil which is changed to ditch filled with biochar and macadam 32-63mm to save the trees with infiltration of stormwater.

- the first time we sow grass on 2-6mm 3 parts 1 part biochar 100mm
STRUCTURAL SOIL WITH BIOCHAR

The City of Stockholm have set as a goal to create sustainable and durable plant beds from locally sourced materials. Structural soils with biochar binds carbon from the atmosphere and reduces leaching of nutrients.
DAGVATTENFÖRDRÖJNING - GRÄSYTA MED KOLMAKADAM

Infiltrationsrör φ 110 (längd ca 4 m) förläggs i två riktningar från brunnen längs med växtbädden

Tätt plaströr φ 200

Brunnsbetäckning med sidointag

Dagvattenbrunn φ 400 med tät betäckning

Körbana

Geotextil

850 mm makadam 32-63 mm

Med 15% biokol med näring

100-150 mm makadam 4-8 mm med 25 volym% näringsberikad biokol

50 mm makadam 8-16 mm

Stödremsa 250 mm bredd makadam 8-
Avjämnsas med makadam 2-6 mm

50 mm biokol (ogödslad)

Luckring av terrass 200 mm
Valhallavägen
100mm mix of macadam 2-6mm 3 parts, 1 part biochar, and grass seed

32-63mm and 15% biochar
800mm

8-16mm
30mm

32-63mm and 15% biochar
800mm

Valhallavägen
2016
2-6mm 3 parts 1 part biochar
100mm and grass seeds on the surface
Pilgatan 2014

Biochar with infiltration of stormwater
Magnolias and perennials
1 part biochar 0-10mm and 3 parts crushed granite size 4-8 mm
800mm deep.
Biochar and stone chips = crushed granite 3/4 (2-6mm) and nutrient-enriched charcoal 1/4. volume
Biochar and stone chips = crushed granite 3/4 (2-6mm) and nutrient-enriched charcoal 1/4. volume

the material acts as an open magasin able to receive storm water to at least 30% of its volume
10 000 cherry trees

macadam 8-16mm
10% biokol 0-10mm

700mm deep
150mm wide
our trenches has a mixture of 1 part biochar
9 parts 4-8 mm crushed granite
mykorrhiza
Reduce the risk of floods

Reduce the presence of particles and carbon dioxide in the air

counteract the heat island effect

Reduce the load on the storm water systems, thereby reducing pollution in Lake Mälaren and the Baltic Sea
300mm deep, = crushed granite 6/8 volume parts (2-6mm) and nutrient-enriched biochar (50%) + compost (50%) 2/8 volume parts
Magnolia tripetala
300mm deep, = crushed granite 6/8 volume parts (2-6mm) and nutrient-enriched biochar (50%) + compost (50%) 2/8 volume parts

Lettuce artichoke potatoes
2017
First potatoes grown in macadam biochar and compost
Växtbäddar i Stockholms stad
– en handbok 2017
Benefits of Soil Best Practices

For Builders, Developers, and Landscape Contractors
• Better landscape appearance = happier customers, which sells the next job
• Better erosion control
• Better stormwater management
• Easier, faster planting in amended soil
• Much better plant survival (fewer callbacks for dying plants and lawns)

For Property Owners
• Easier, cheaper landscape maintenance
• Up to 50% less summer irrigation needs
• Lower fertilizer needs
• Much less pesticides and herbicides needed – easier, and healthier for families
• Better landscape appearance, all year ’round

For Our Waterways, Salmon, and Other Wildlife
• Reduced stormwater runoff = less erosion and sediment in salmon streams
• Increased groundwater recharge = better summer stream flows
• Less demand for irrigation water supply = more water in rivers for wildlife
• Bio-filtration of urban pollutants (running through compost-amended soil filters out 60-95% of contaminants)
• Less need for fertilizers and pesticides, so less washing off into streams

http://www.soilsforsalmon.org/why.htm
http://www.soilsforsalmon.org/how.htm