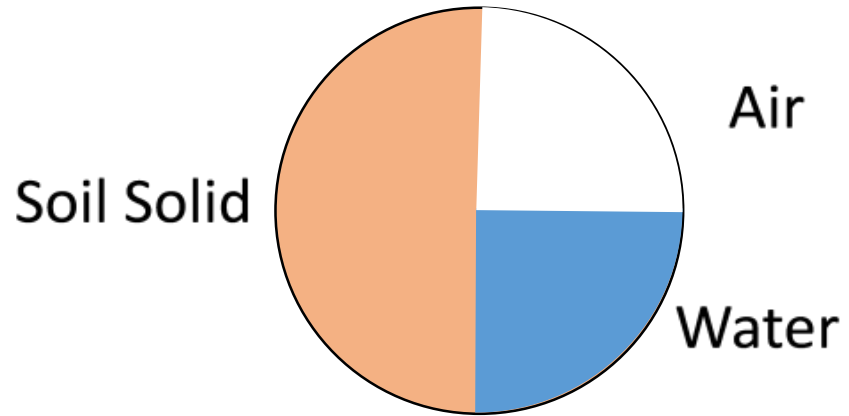
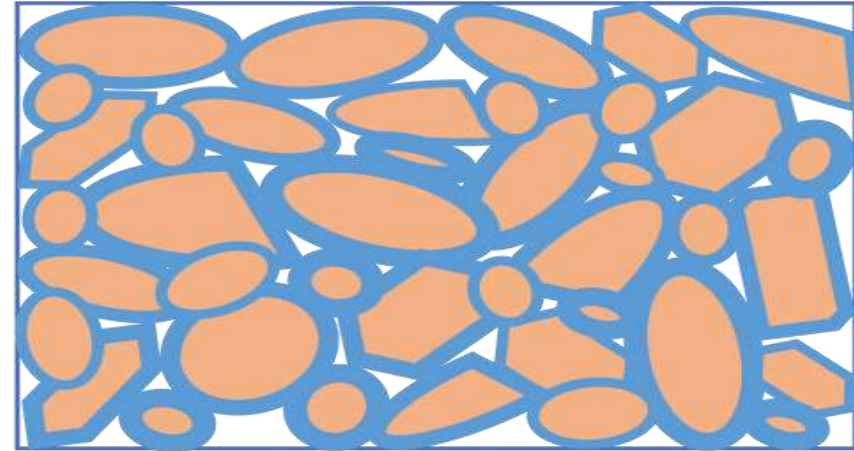
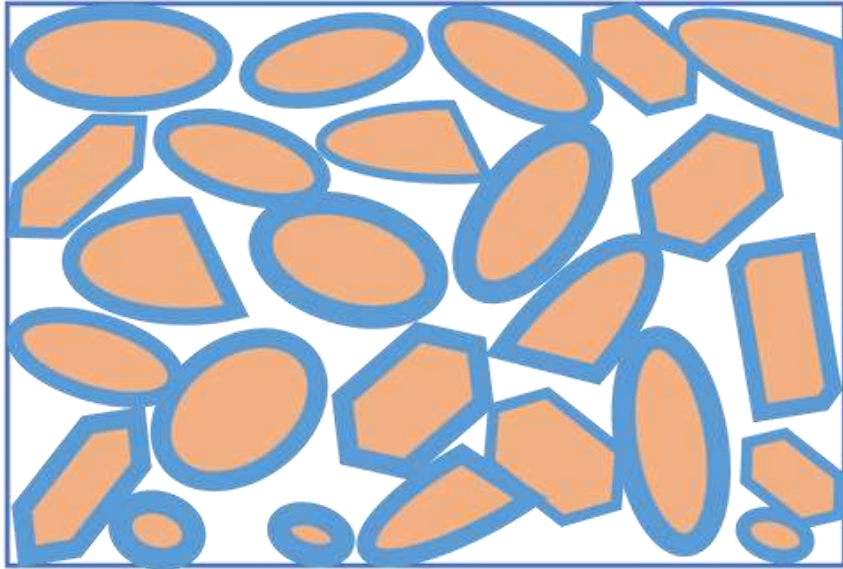


# Hate love affair between trees and pavement

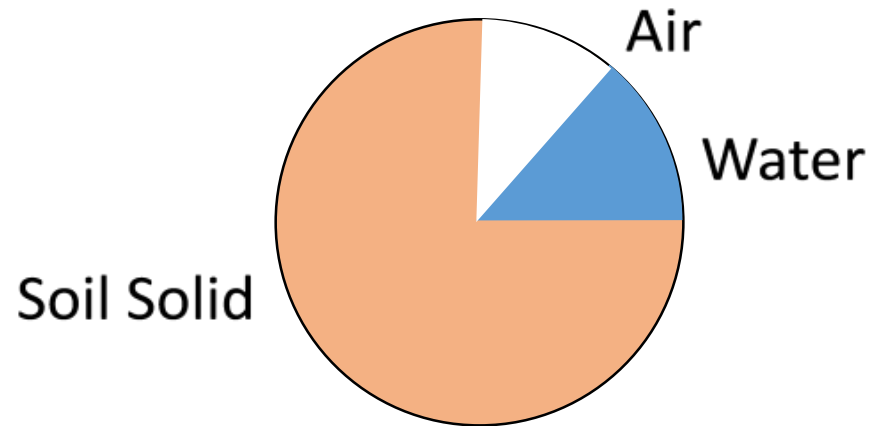


**Werner Hendriks TreeBuilders**  
**w.Hendriks@treebuilders.eu**  
**Feb. 2019 Ramat Hanadiv**

# Ideal Soil ?



**Uncompact**



**Compact**

# Urban tree planting system

# No system



Trees planted the same size and same date

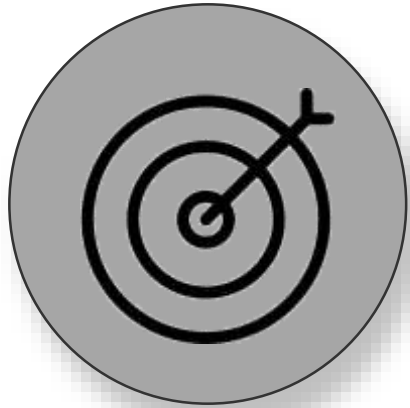
# Urban tree planting system

# No system



Trees planted the same size and same date

# The best urban treeplanting solutions ?



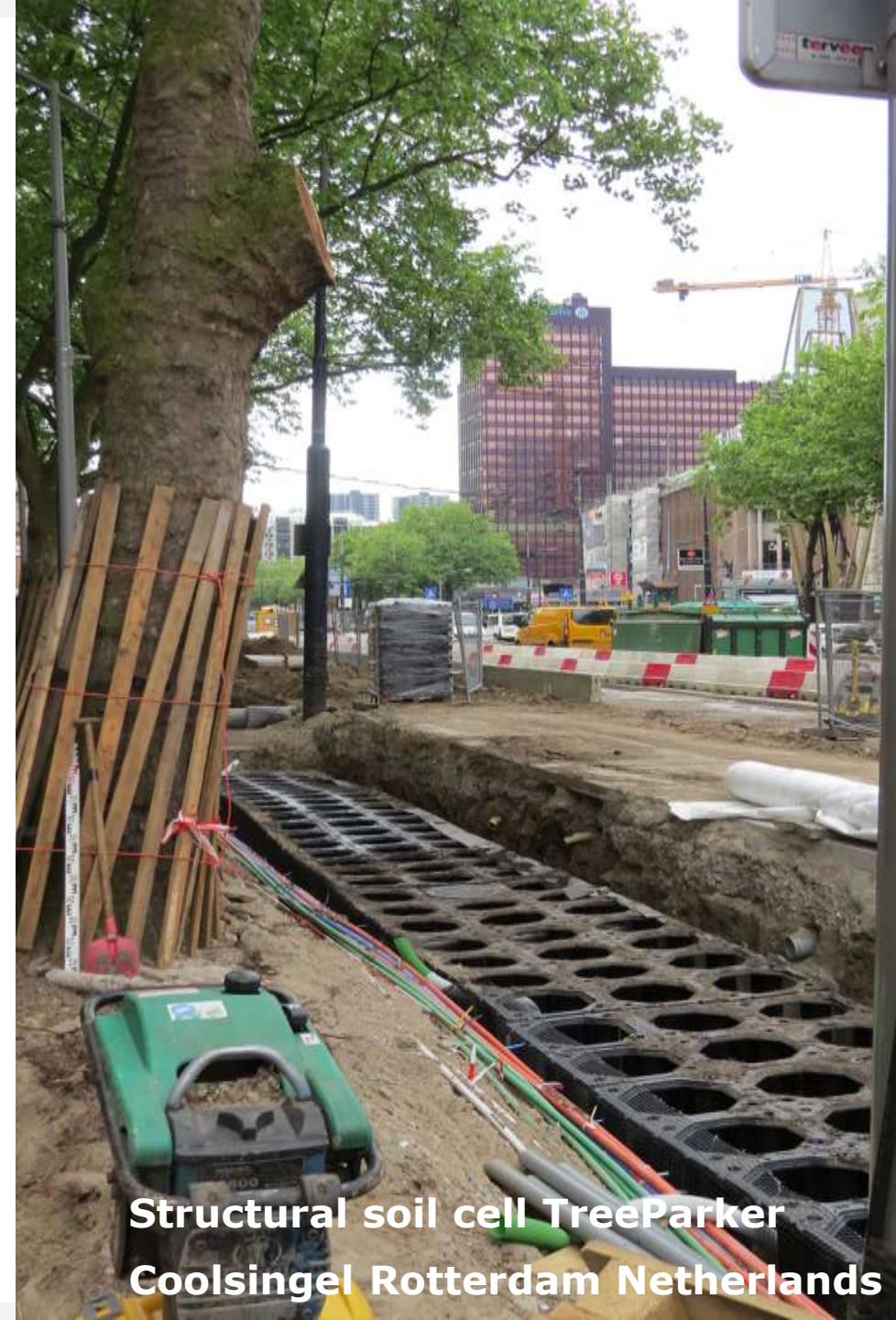
**Targets/goals**



**Budgets**



**Expectations**



**Structural soil cell TreeParker  
Coolsingel Rotterdam Netherlands**



# Urban tree planting systems

## Basic knowledge

- Science of trees
- Soil science
- Road foundations
- Designing trees

## Context

- City scape
- Local condition

## Different approaches

- Load spreading solutions
- Load relieving solutions



# Science of trees

# Science of trees



**It is all about soil volume**



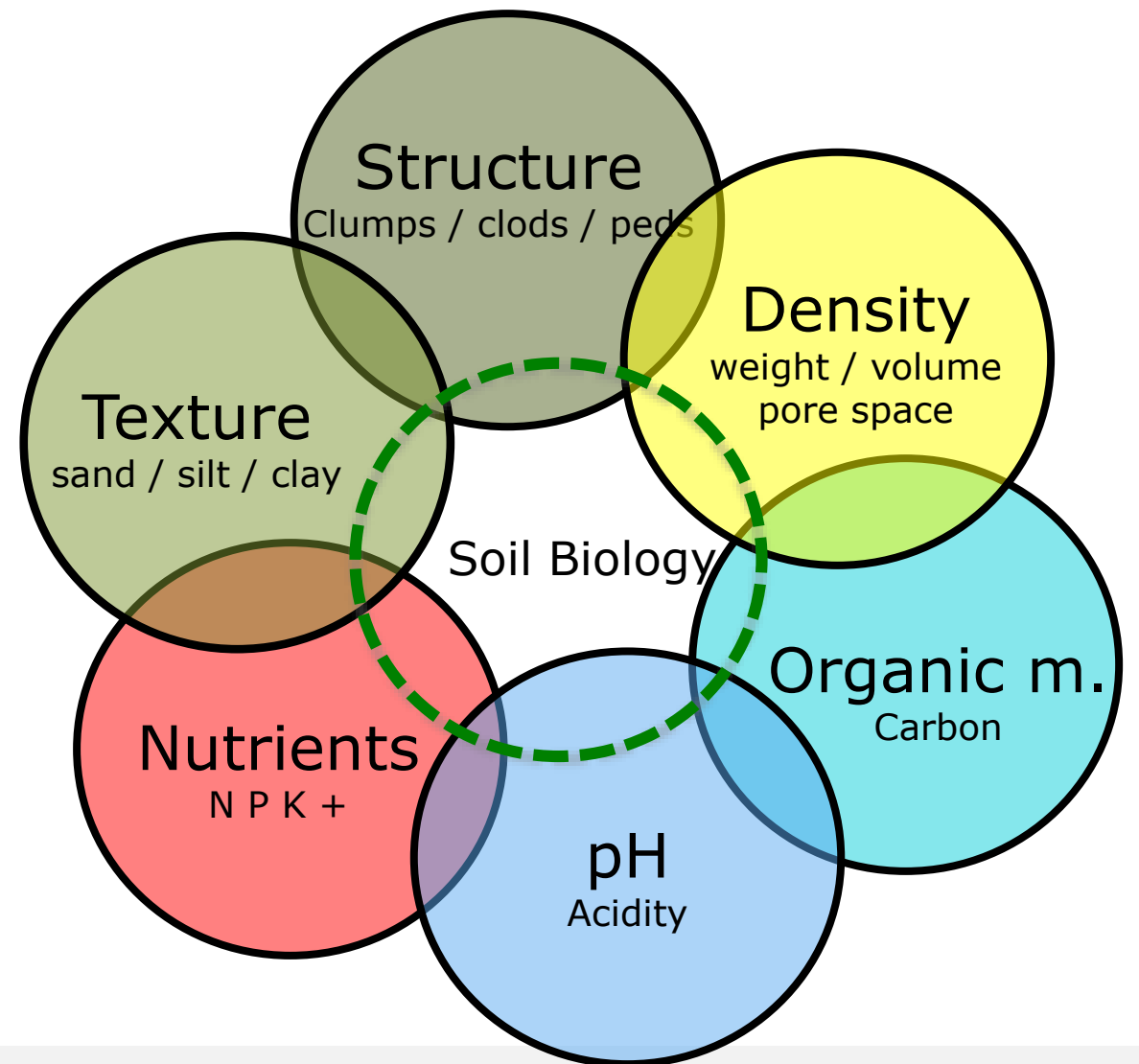


**Soil science**



# Whats the best soil for trees?

**Uncompacted top soil**





**Road foundation**



# compaction, compaction and compaction

**Load capacity**

Traffic load

**No settlement**

Subsoil conditions

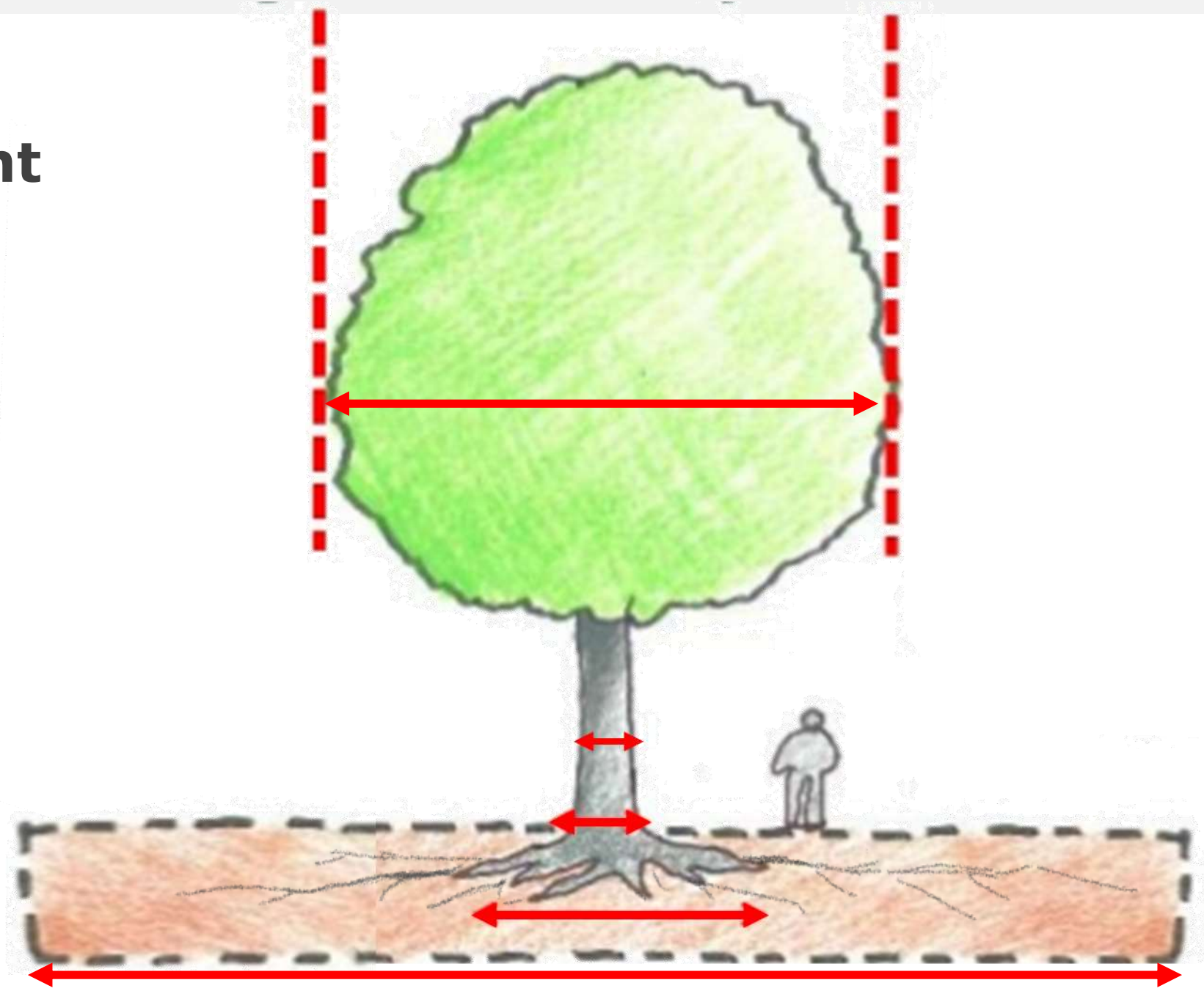


# Desiging trees

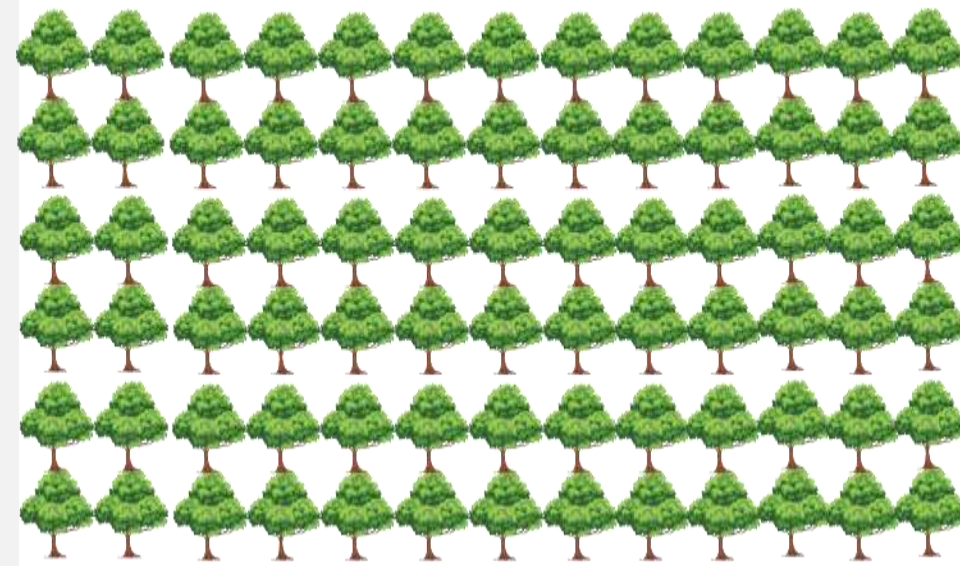
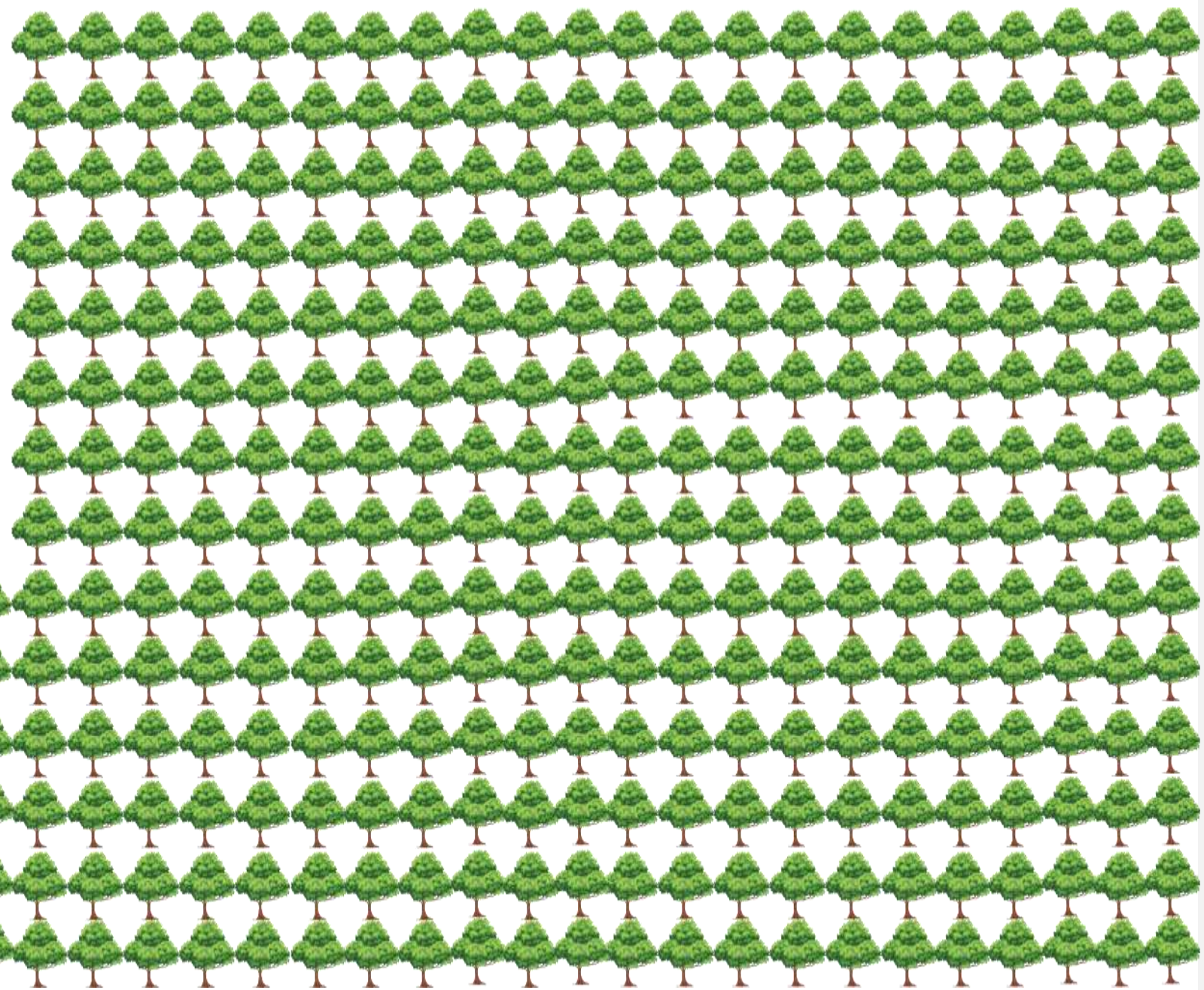
# Treepit design: Do it ones do it right



**Plantsize design**



**Design for future tree**





**Context; city scape**





# Root heave

## **Anchor roots**

Lifting up curbstones/  
pavement around the tree

## **Feeder roots**

Lifting up pavers asphalt  
further away from the tree



# Utilities

**Rules regulations**

**Work around utilities**

**Integrating utilities**

**Roots penetrating utilities**



# Deadlines

**weather conditions**

**savings on budget**

**Protections of soil  
conditions**



**Local conditions**





# Urban tree planting solutions



US: 1<sup>e</sup> susp. Pavem.



NL: Amsterdam treesoil



NL: Skeletonsoil Lava 100-150



US: 1<sup>e</sup> experiment prefab concrete



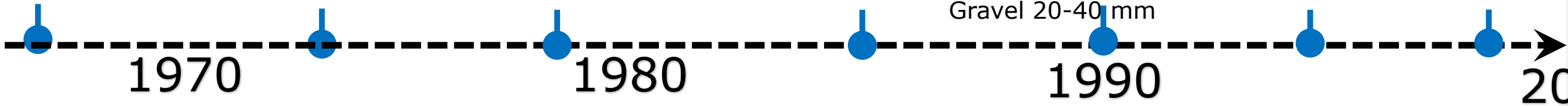
US: Cu soil (patented soilmix) Gravel 20-40 mm



NL: Soil mix no water



NL: waterboxes



NL; 1<sup>e</sup> commercial Concrete susp. pavement



US: Silvacell 1<sup>e</sup> commercial PP struc. soil cell



SE: Stockholm method RBSS+Biochar



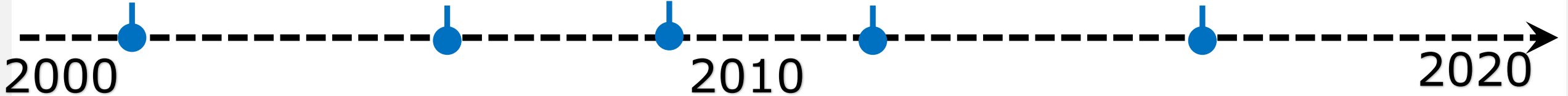
NL: Urbangranulate 40% soil volume



NL: structural Soil cell + bioretention



Trend: Larger rocks



# Bartlett tree research (second research started in 2014)



SILVA CELLS



STRATA CELLS



SAND BASED  
STRUCTURAL SOIL



GRAVEL BASED  
STRUCTURAL SOIL







# Solutions to think of when planting new trees

## **Structural soil**

Root penetrable  
road foundation

---

## **Load support system**

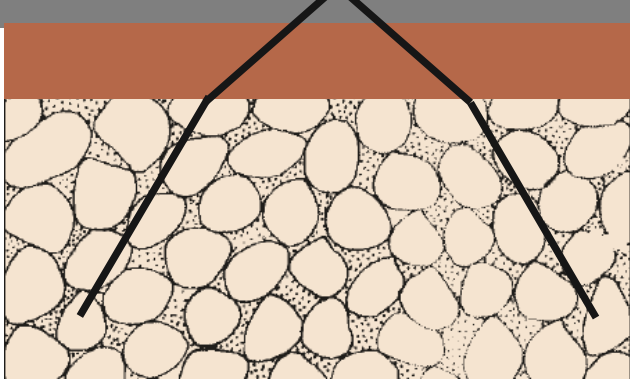
Pressure spreading tool

---

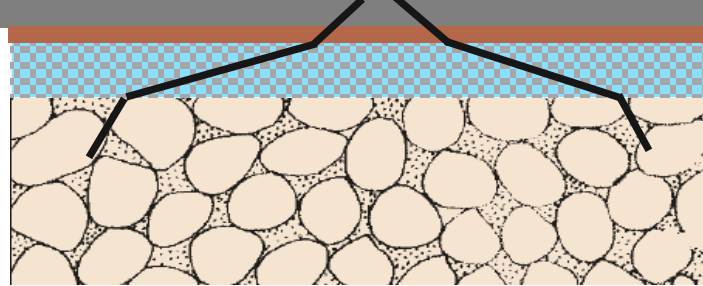
## **Suspended pavement systems**

Basement filled with  
uncompacted soil

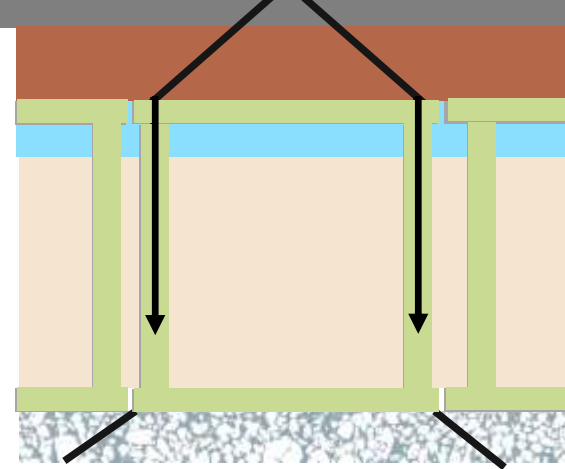
# main approaches



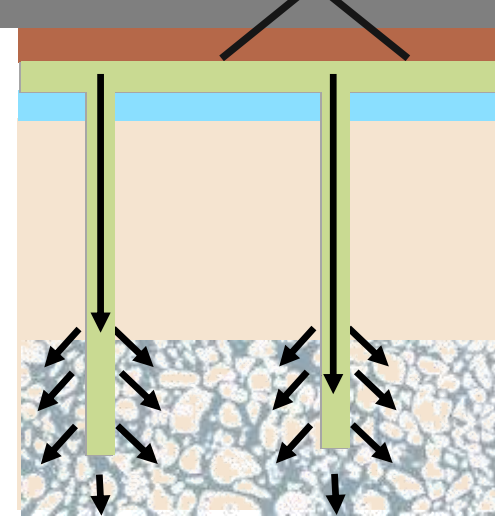
Structural soil



Load support system



Suspended pavement system

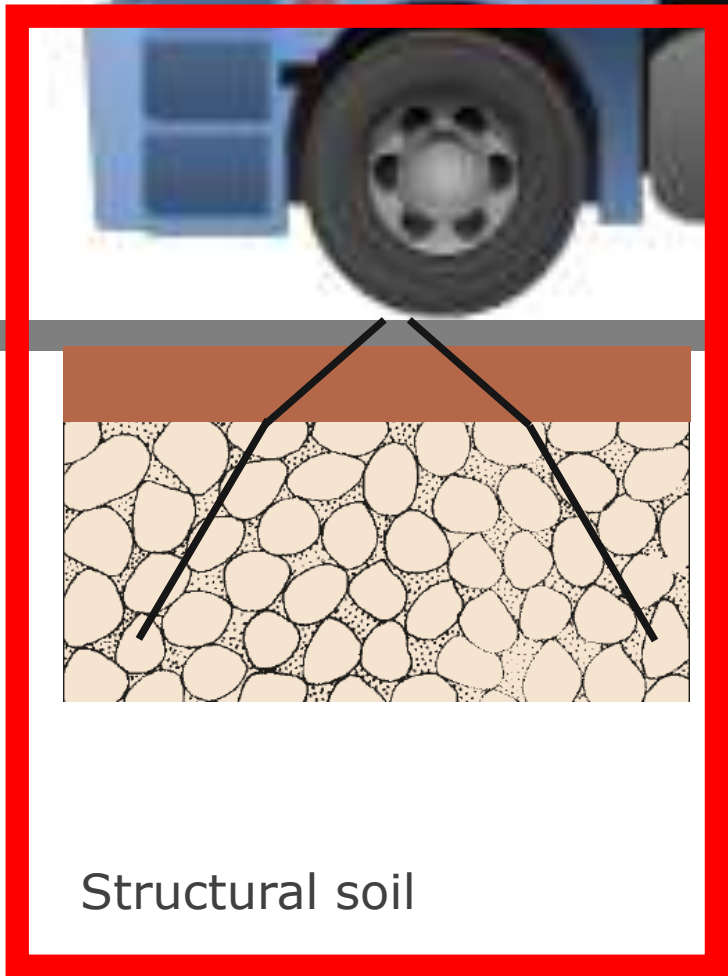


Root protection bridge

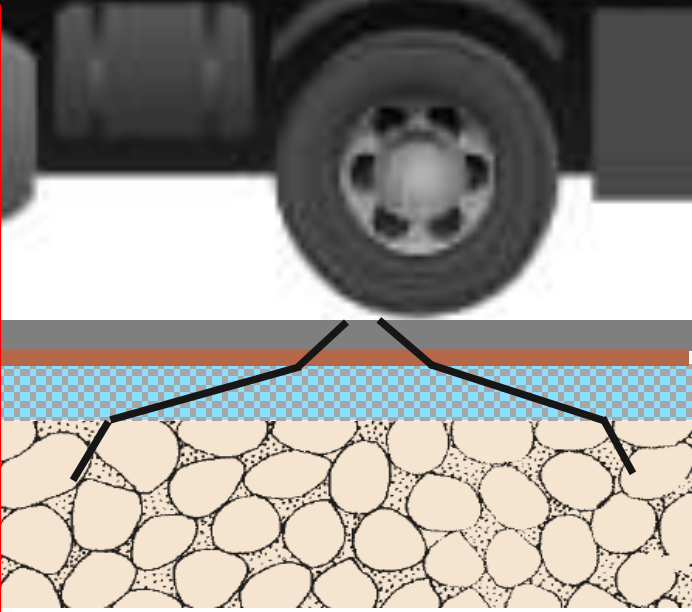
load spreading solutions

Load relieving solutions

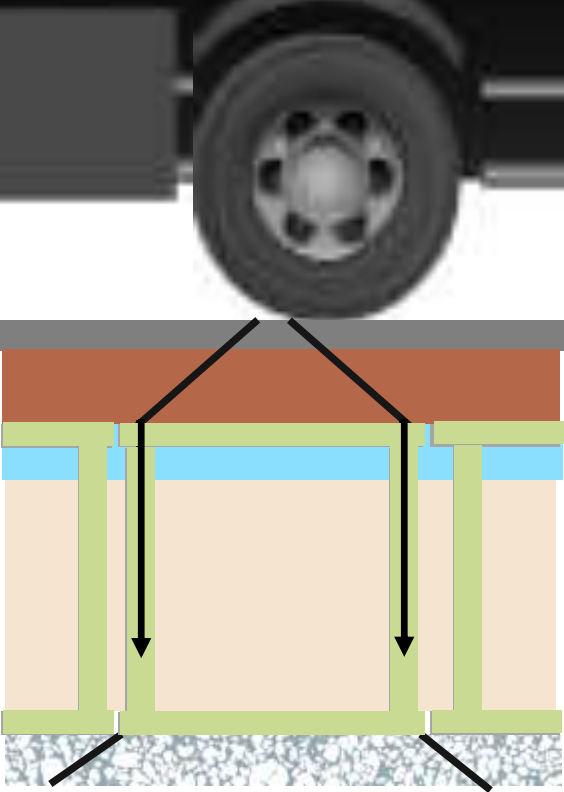
# main approaches



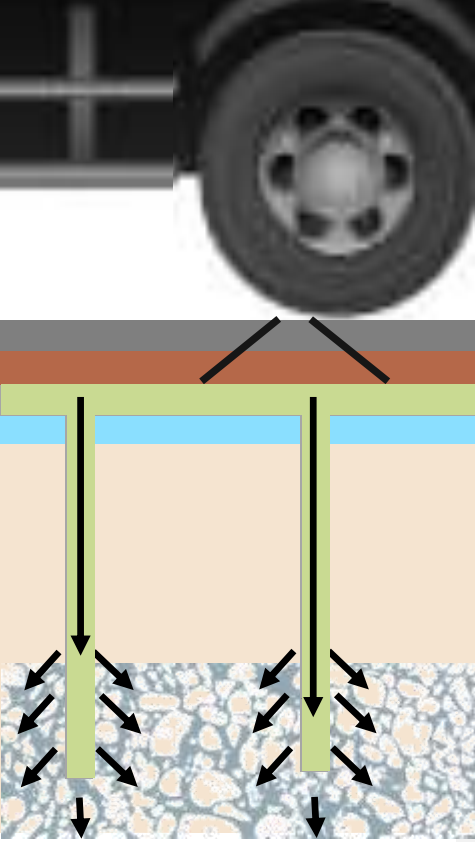
Structural soil



Load support system



Suspended pavement system



Root protection bridge

Load spreading solutions

Load relieving solutions

# Structural soil



Sand Based  
SBSS



Rock Based  
RBSS

# Principle of structural soil





**Rock based structural soil**

# ingredients ; Rock based structural soil



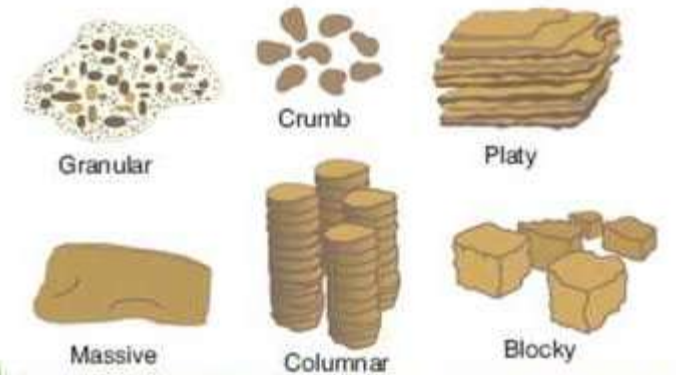
Rock/Gravel    +    soil    =    structural soil  
Ca 70 - 80%        20 - 30%



# Rock

**Porous rock**

**Solid rock**







# Soil

**Sand Silt Clay**  
**Organic matter**

**Additive:**

Vertilizer

Biochar

Hydrogel



# Installing

## Washing in soil

The best way  
if done correctly

## Prefab mixing

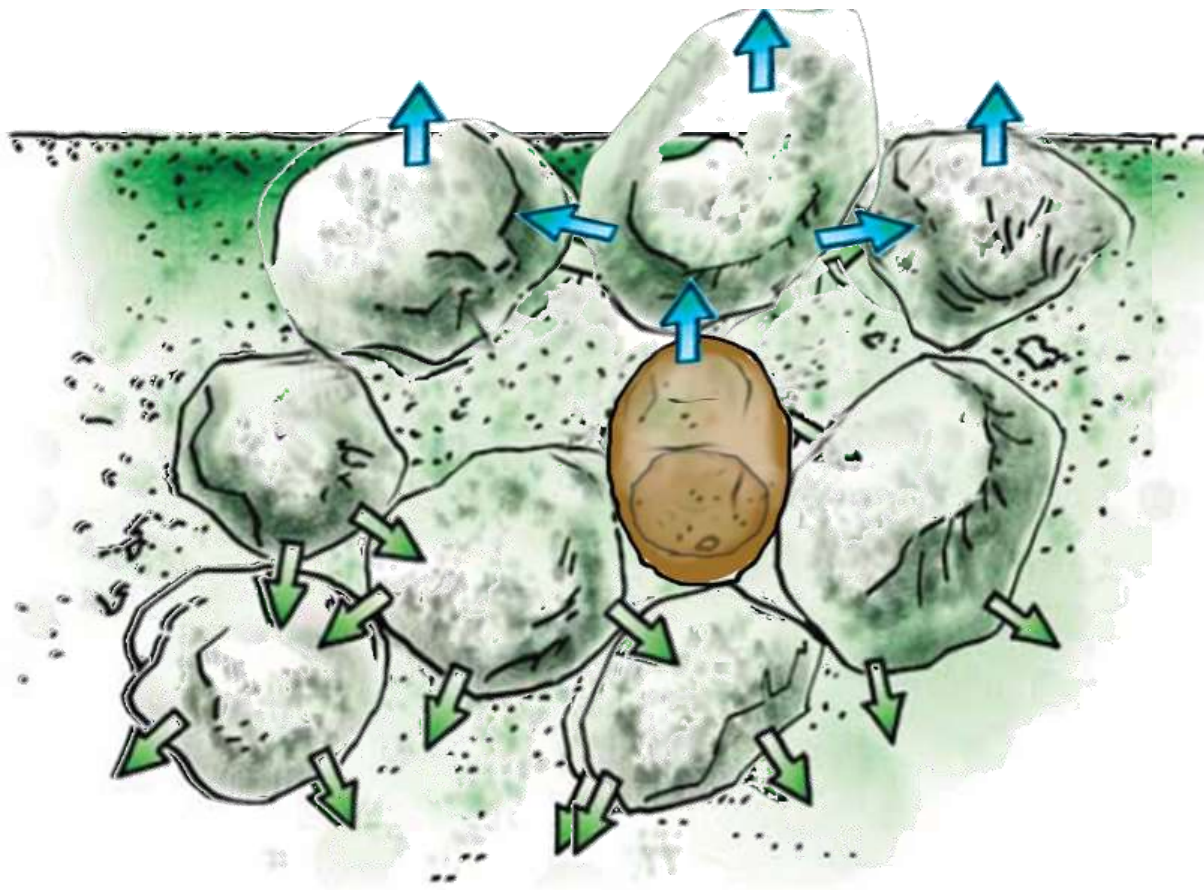
Less mistakes possible

## Compacting by layer

Compact each layer of 20-30 cm

Tree root guiding  
Aeration  
Irrigation

# Roots in structural soil



## Postponing rootheave

Size of the stone

Tree species

Weaving roots





# Specifying structural soil

## By name

Stockholm method

Urbangranulate

CU-soil

or

## By functionality

Load capacity

Pore space %

Soil volume %

Water permeability rate

Watercapacity

pH EC Organic matter

Etc



# Structural soil in general

- + Heavy traffic loads (solid rock)
- + Applicable everywhere
- Not all utilities are allowed to cover up with rocky soil
- Postponed rootheave  
(depending stone size)
- Lots of volume needed
- No digging possible by hand



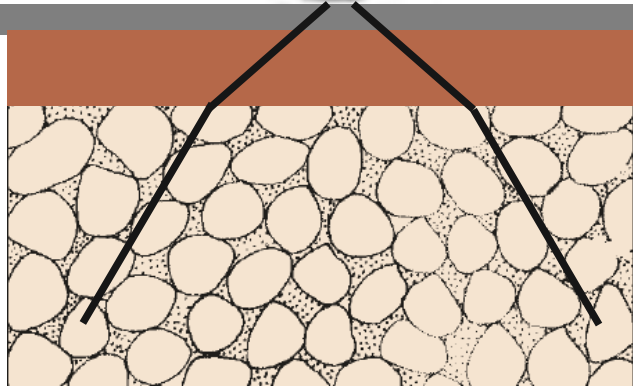
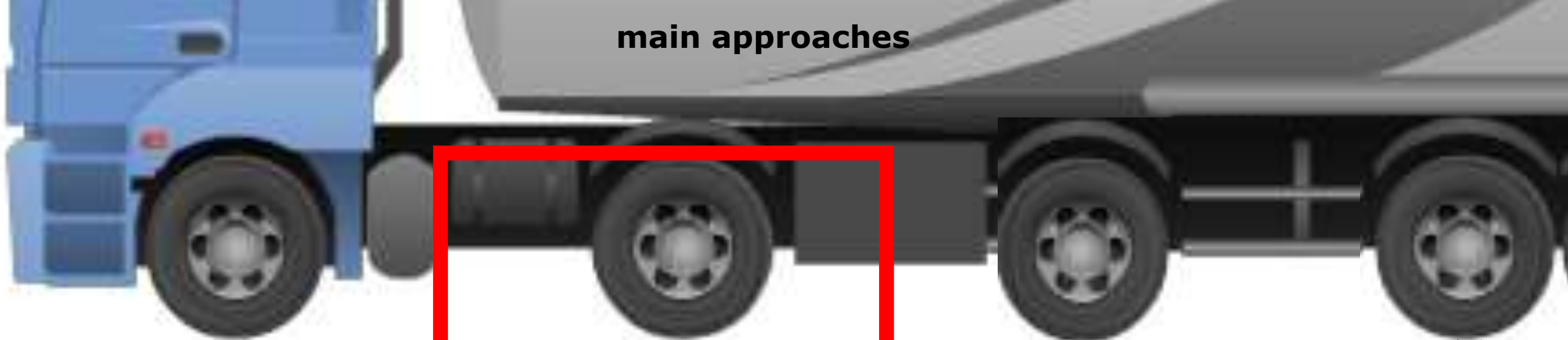
**Sand based structural soil**



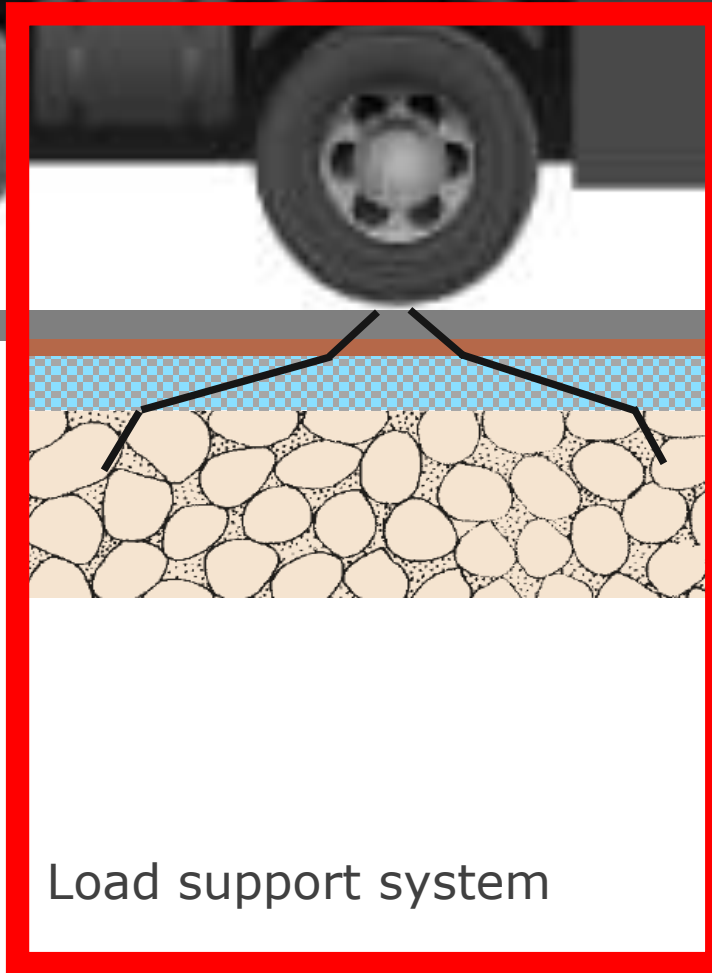
# **SBSS**

- + Applicable everywhere**
- + Intergrating utilities no problem**
- + Easy to use**
  
- Postponed root ehave**
- Lots of volume needed**
- Load bearing capacity**

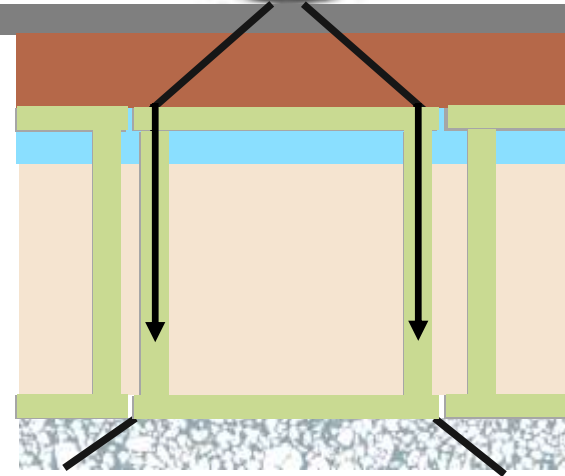
# main approaches



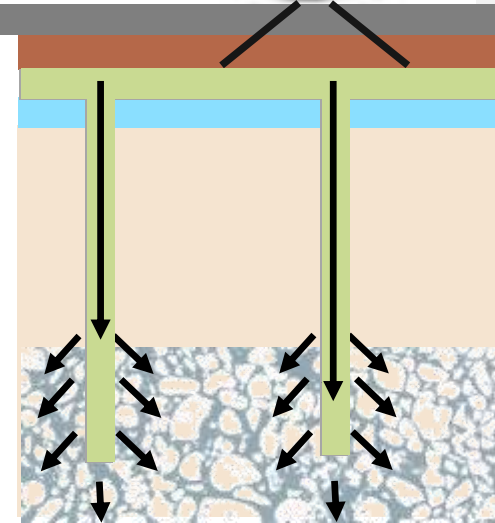
Structural soil



Load support system



Suspended pavement system



Root protection bridge

Load spreading solutions

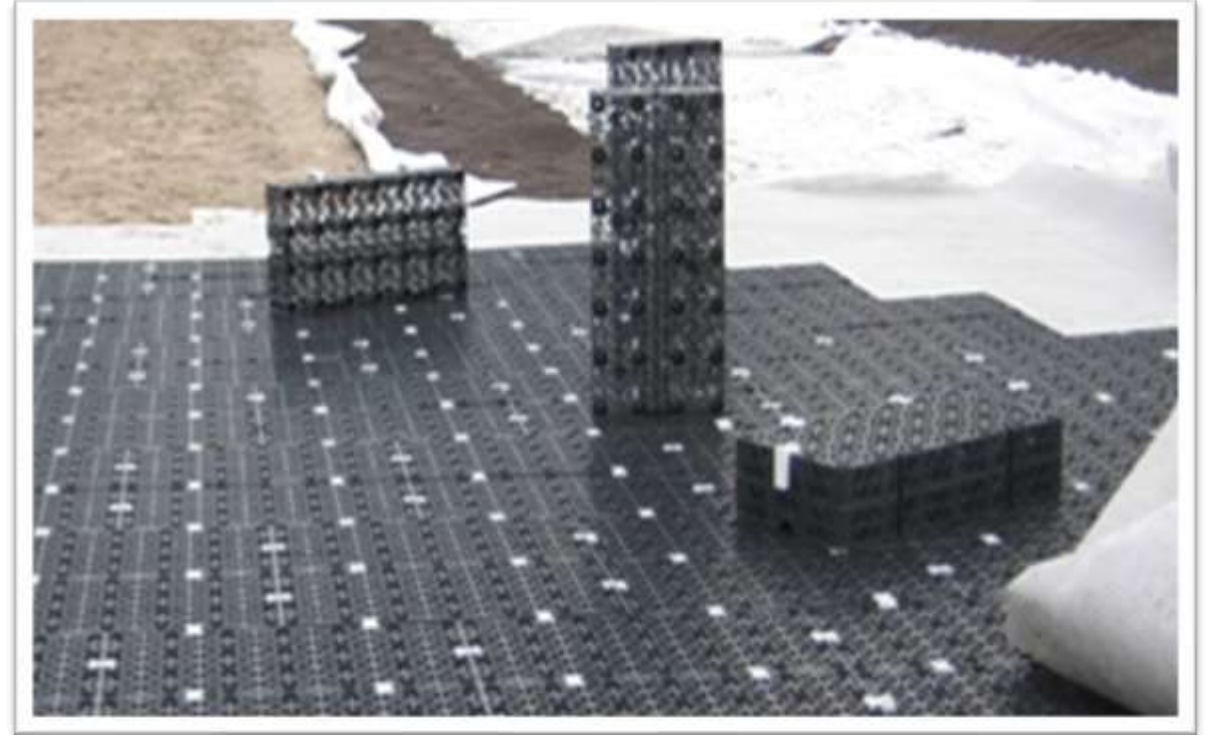
Load relieving solutions



# Load support systems

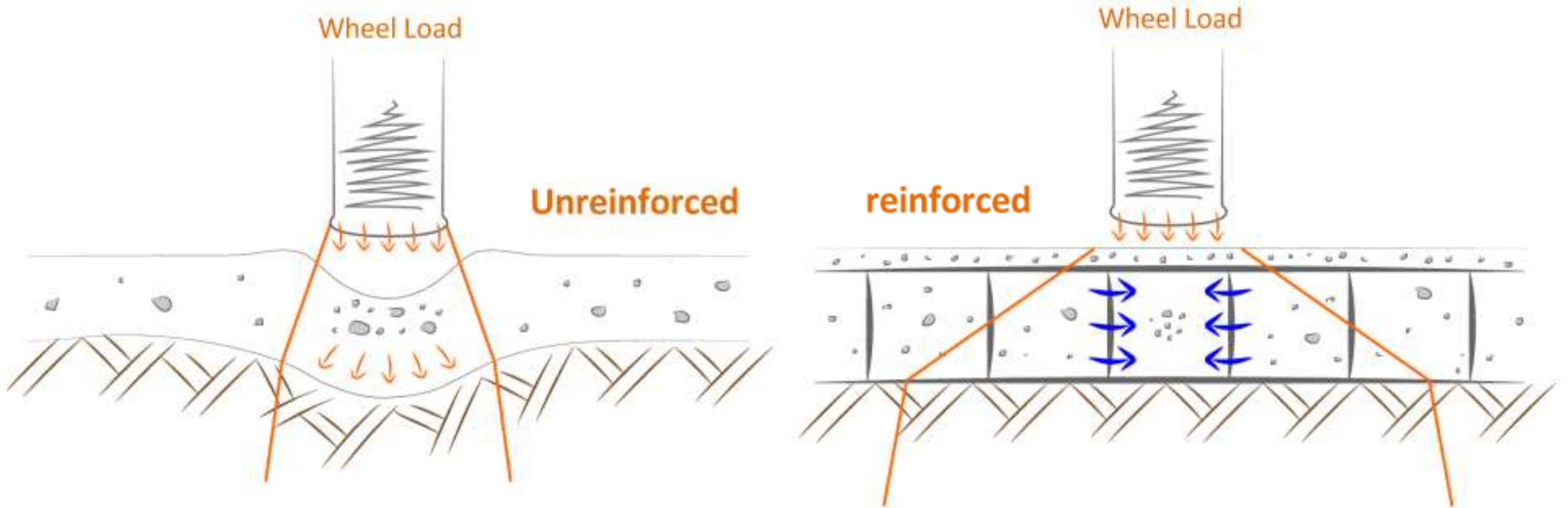


Cellular confinement system (CCS)



Sandwich construction

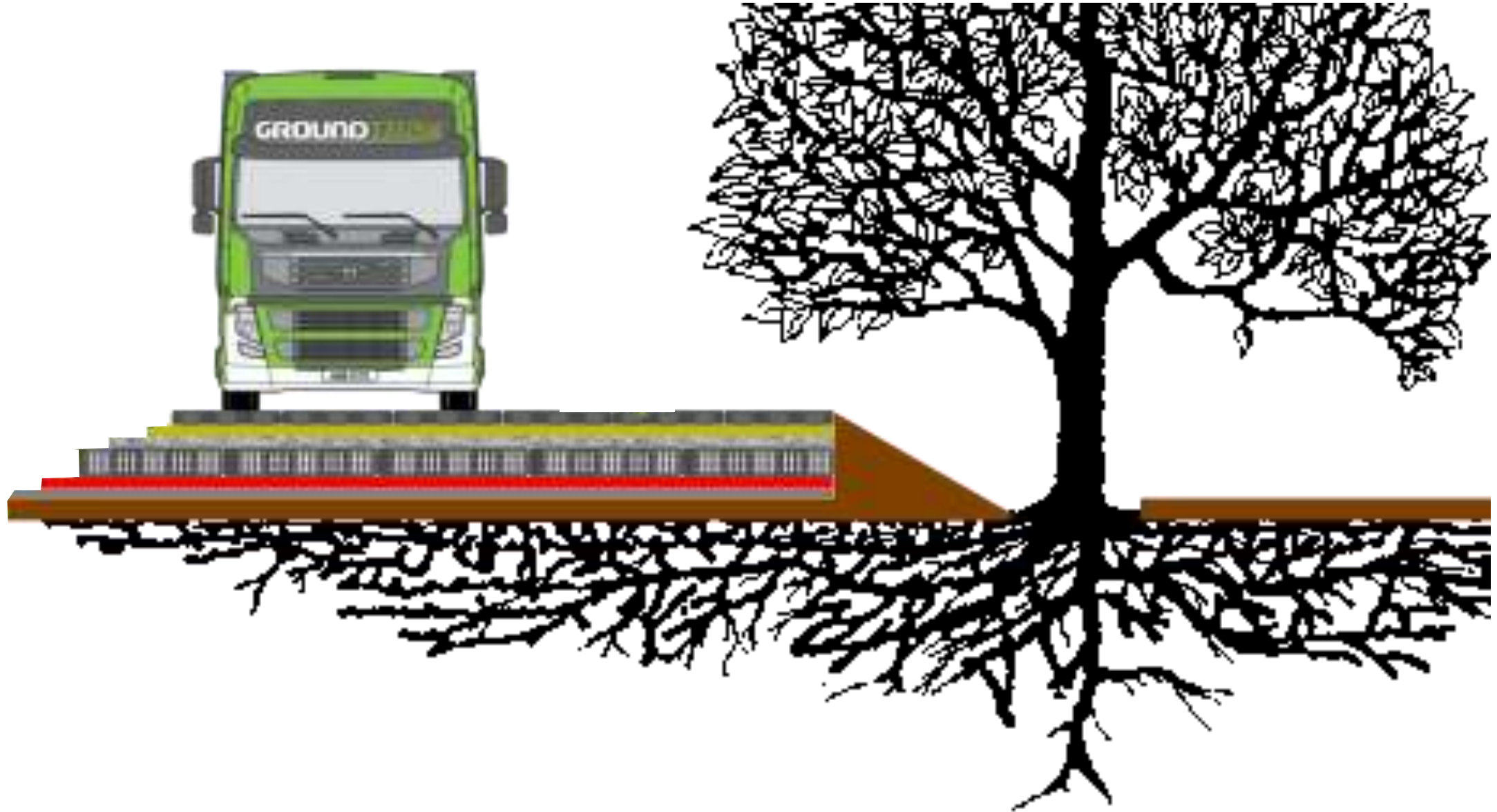
# Principle of load support systems





**Cellular confinement system**

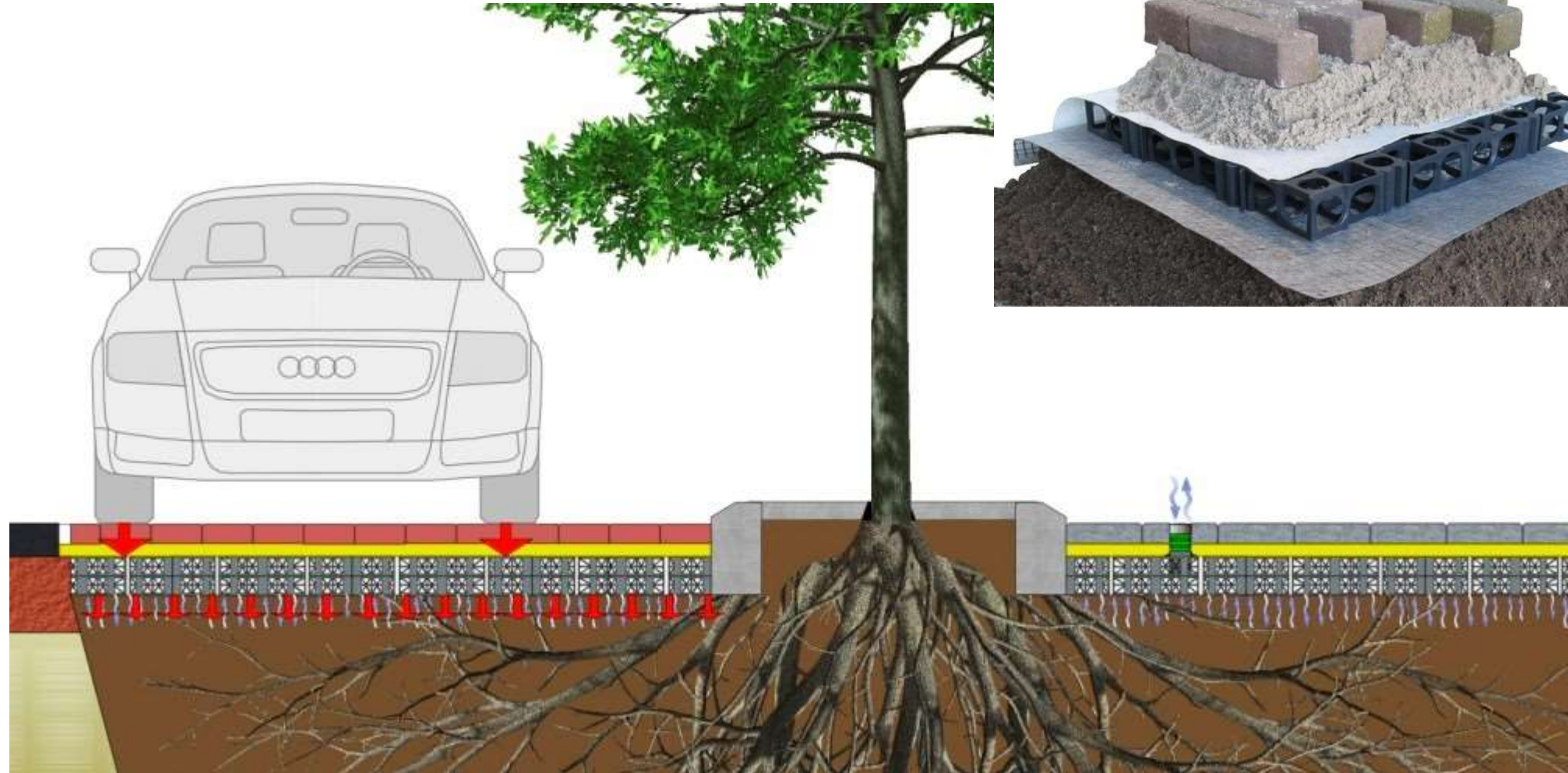
# Principle of cellular confinement system





**Sandwich construction**

# Principle of Sandwich construction





# Functions

## **Load support**

Load spreading

## **Horizontal rootbarrier**

Air-layer will prevent roots from growing up

## **Organic material**

Mulch in the system will have positive effect on tree.



# With or without soil?

**Rootheave increases with:**

**bigger roots**

**closer to the surface**



# Installation

**Pavers**

**Gravel/sand layer**

**Geotextile**

**( Mulch )**

**Sandwichboxes**

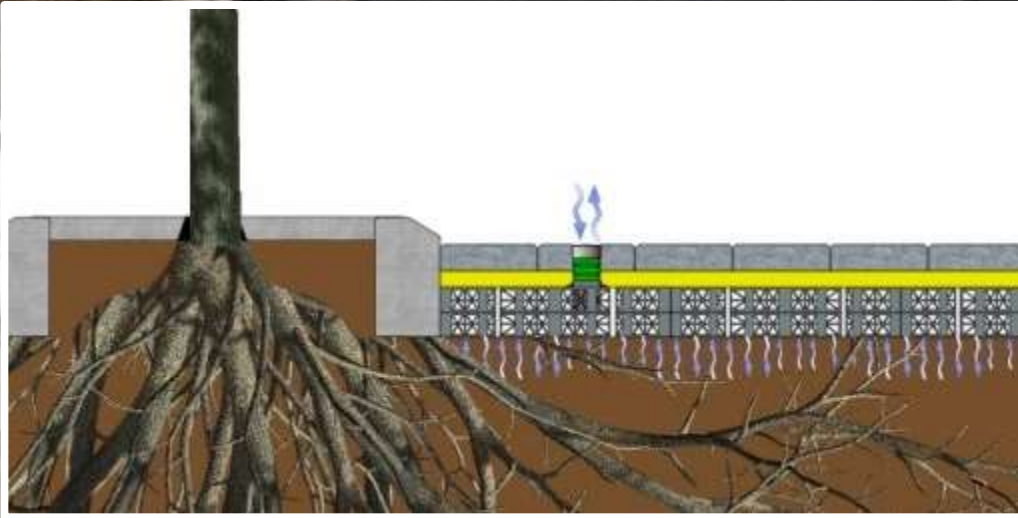
**Reinforced geotextile**

**SBSS / Local soil**

**Tree root guiding**

**Aeration**

**Irrigation**





# Specifying sandwich construction

## By name

Variotreebox/ Sandwichbox

Permavoid/Arborraft

Sandwichpanel

Aqua multibox

or

## By functionality

Maximum load capacity.

Horizontal load capacity

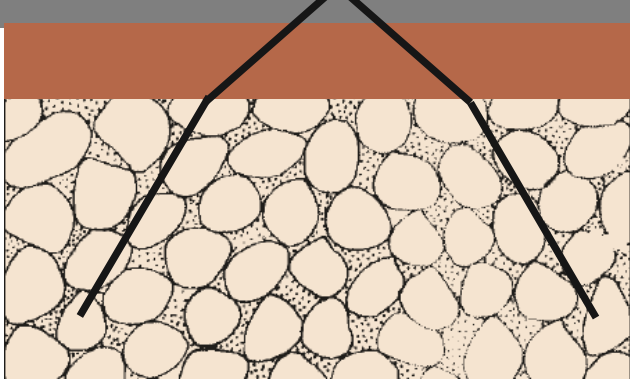
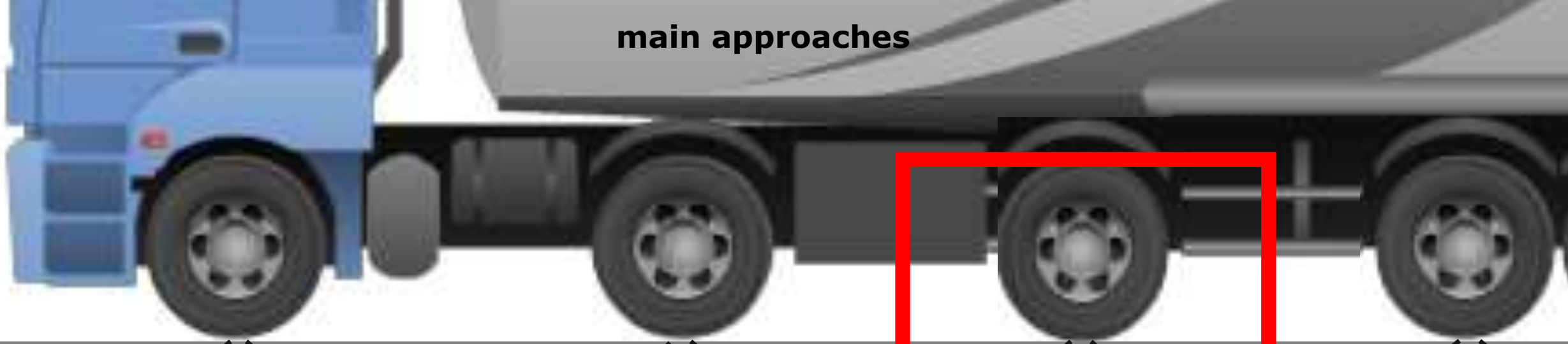
Connection strenght



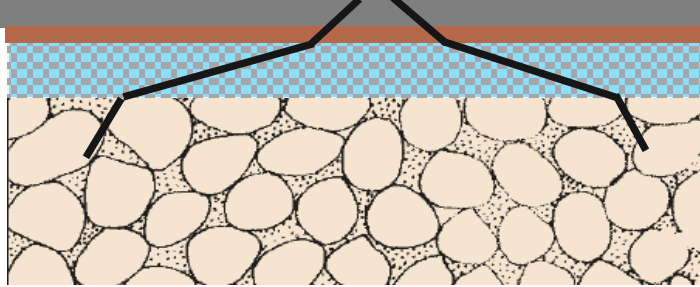
# Sandwichconstructie

- + Load support system
- + Less road foundation needed
  
- Postponed root heave
- Horizontal forces (emergency stop)

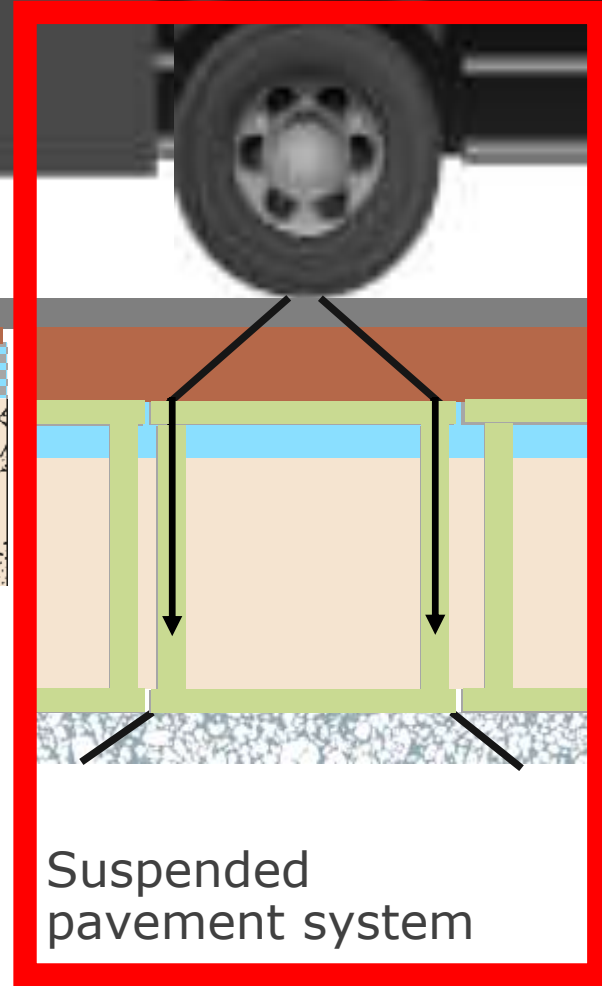
# main approaches



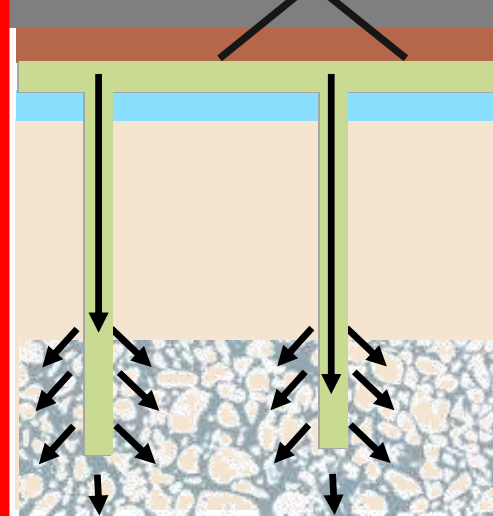
Structural soil



Load support system



Suspended pavement system



Root protection bridge

Load spreading solutions

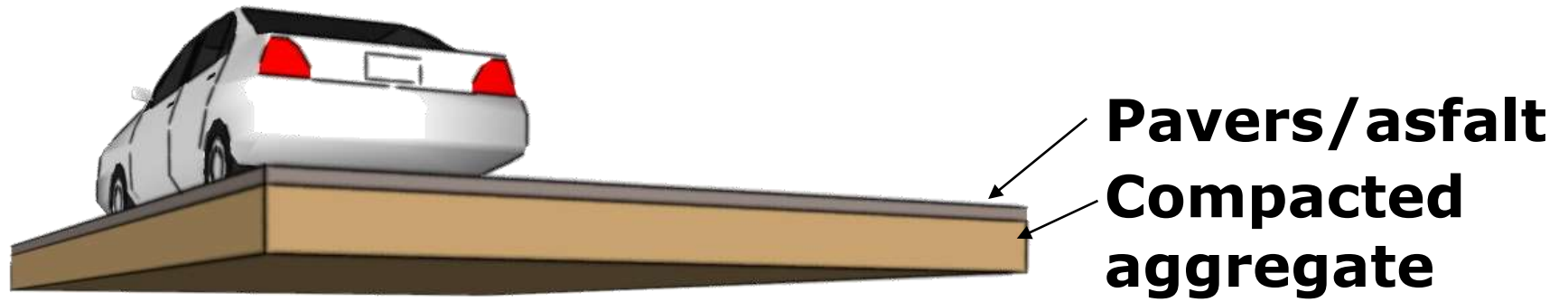
Load relieving solutions



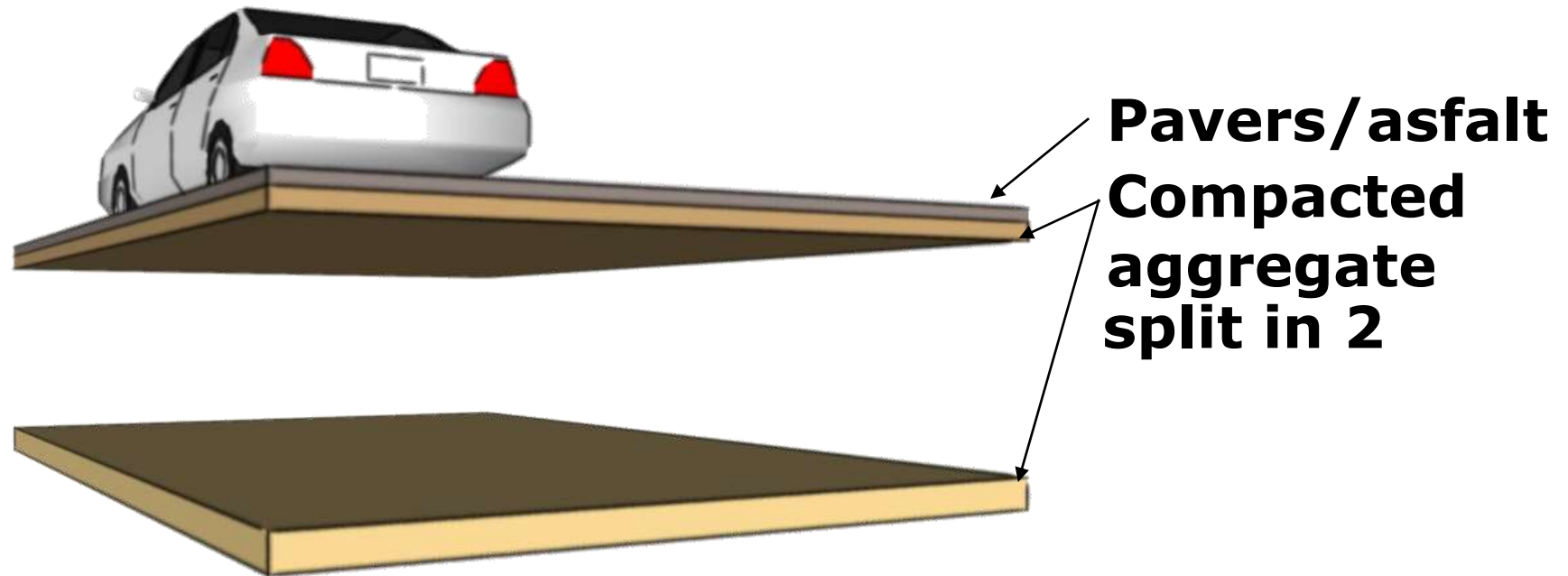
**Suspended pavement**

AT5

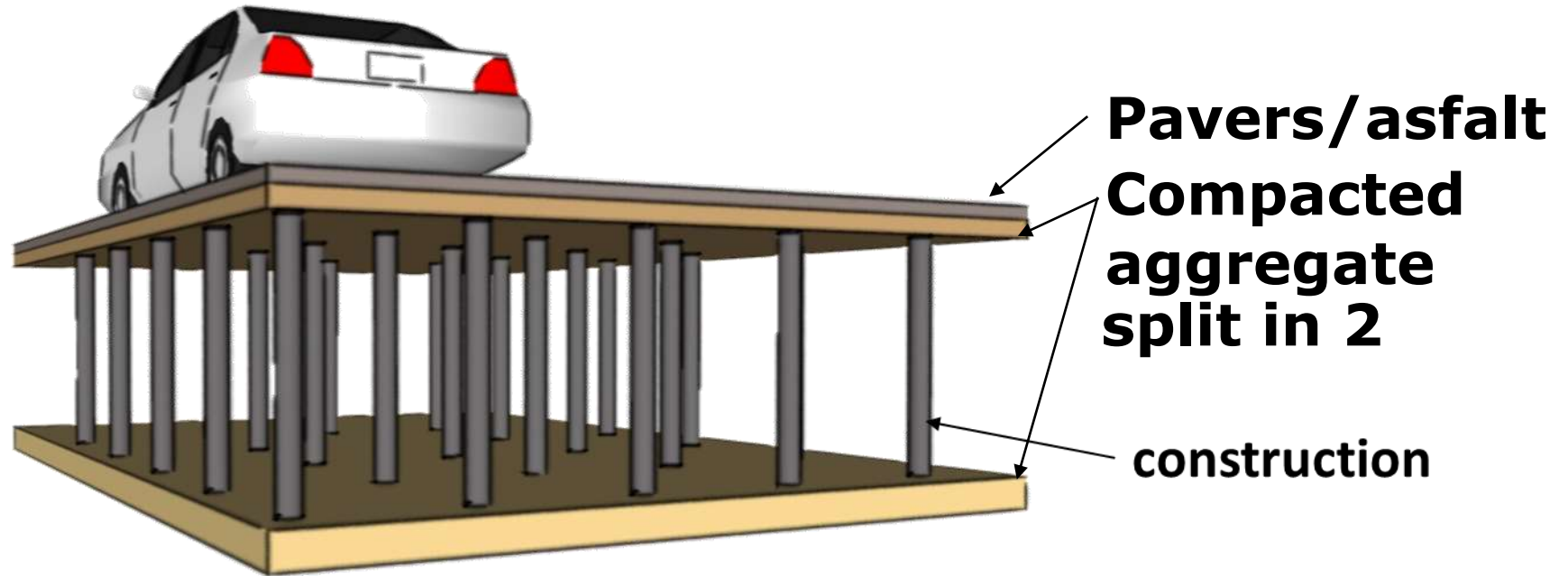
# Principle of suspended pavement system (structural soil cell)



# Principle of suspended pavement system (structural soil cell)

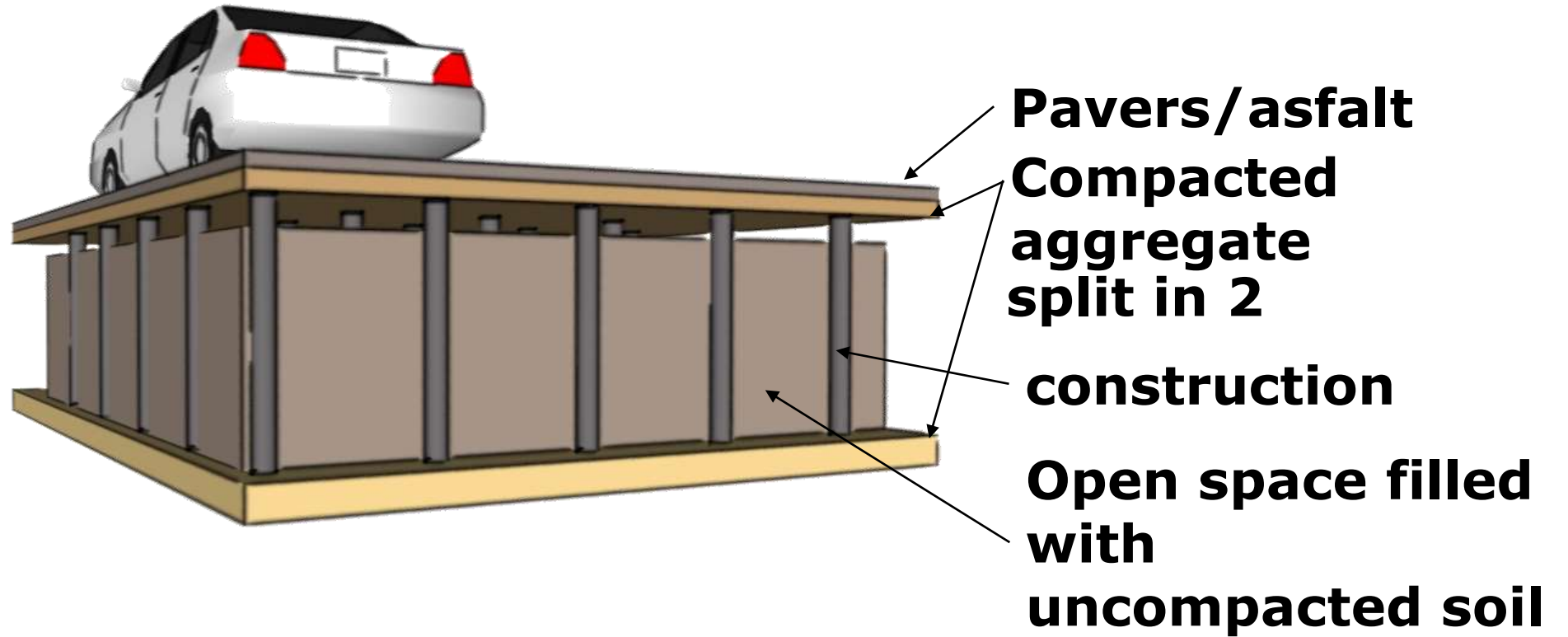


# Principle of suspended pavement system (structural soil cell)

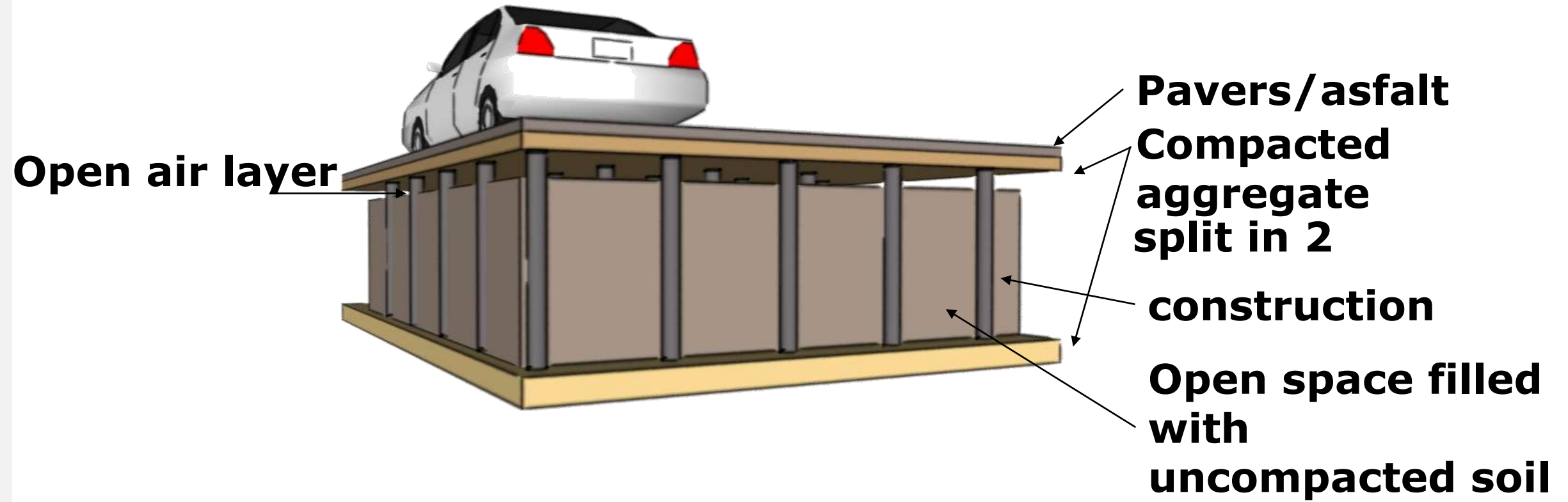




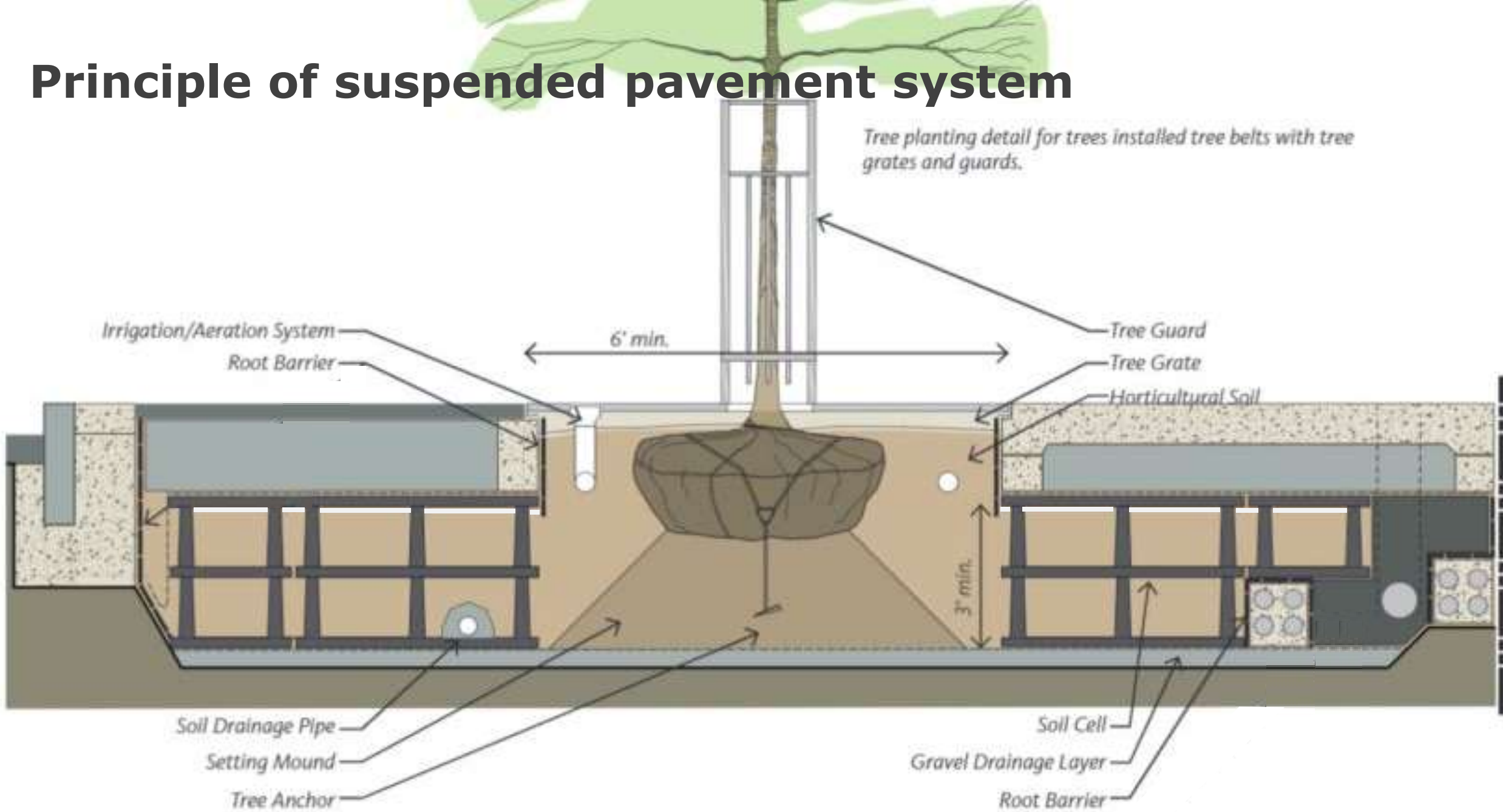
# Principle of suspended pavement system (structural soil cell)



# Principle of suspended pavement system (structural soil cell)



# Principle of suspended pavement system



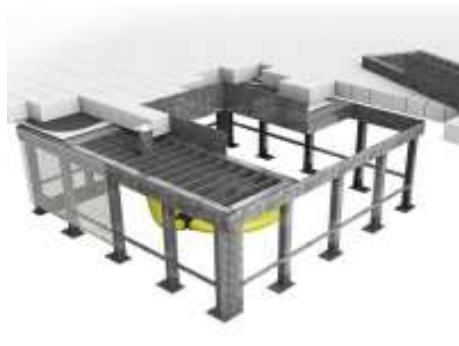
# Supended pavement system

Concrete prefab/ in-situ

Galvanized steel

Combinations

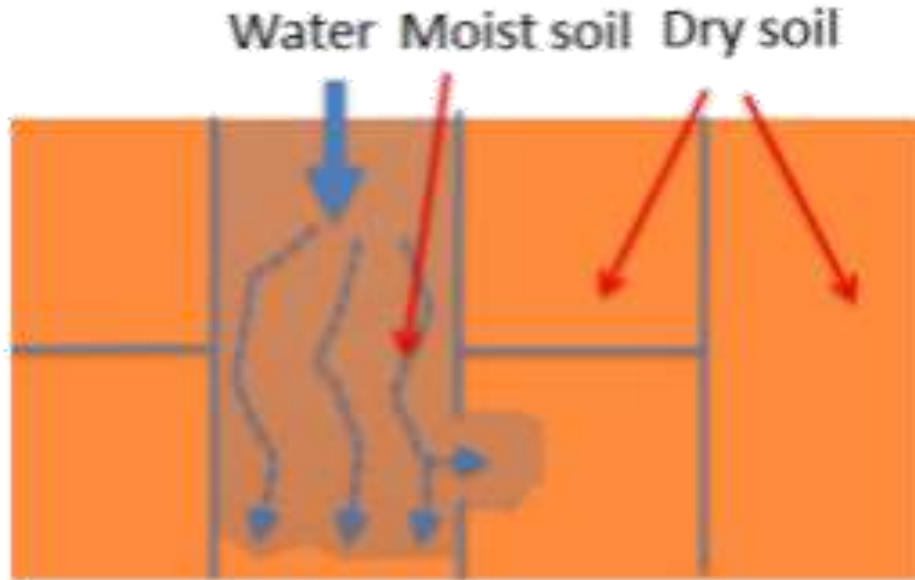
Polymeren



# Structural soil cell

## Segmented soil volumes:

NO natural water and air distribution

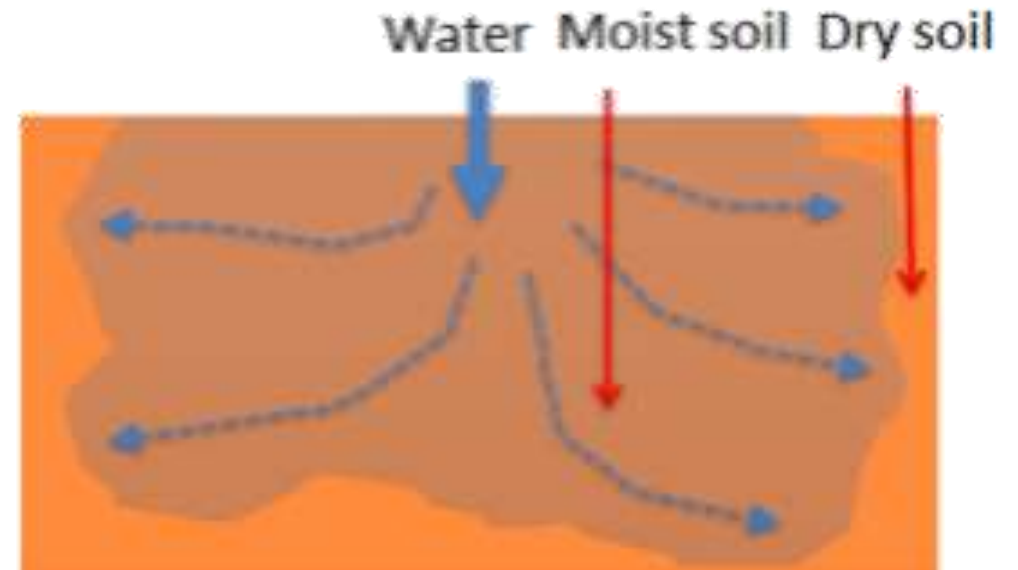


Small openings

How about :  
**BIG roots?**  
Filling in soil?

## 1 soil volume:

Natural water and air distribution



**NO small openings**





# 1<sup>e</sup> or 2<sup>e</sup> floor planting

No wrong no right

Trunkflare

Oxygen

Rats, mice

Garbage





# 1<sup>e</sup> maai veld aanplant

Preventing:

Migration of soil  
Root heave



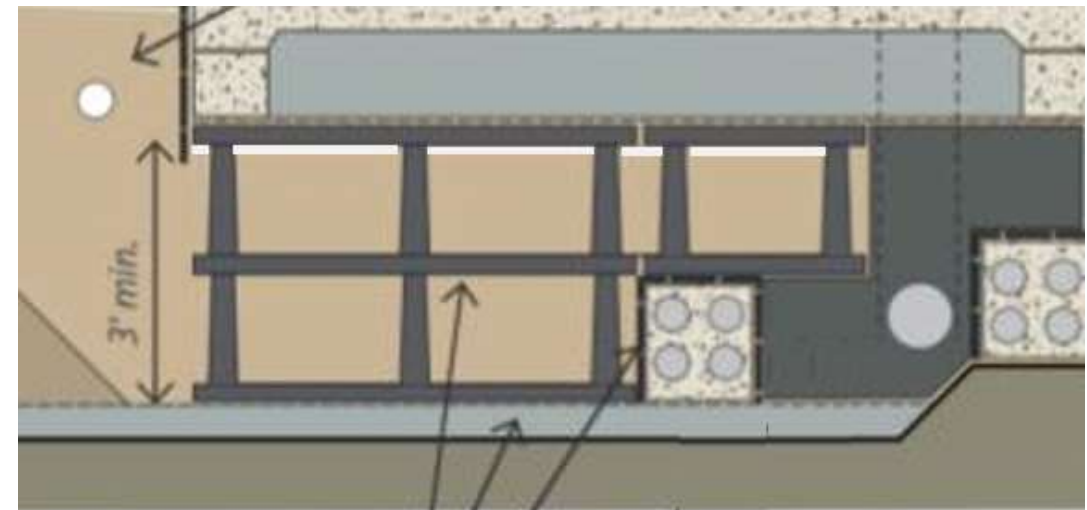




# Utility friendly

No wrong no right

How flexible is the system



Soil Cell  
Gravel Drainage Layer  
Root Barrier



# Specifying structural soil cell

**By name**

Over 20 different systems

or

**By functionality**

Maximum load capacity.

Soil volume inside

Smallest opening for roots

Depth of toplayer

Height of the systems

Aeration, irrigation

Stormwater retention

Garantee



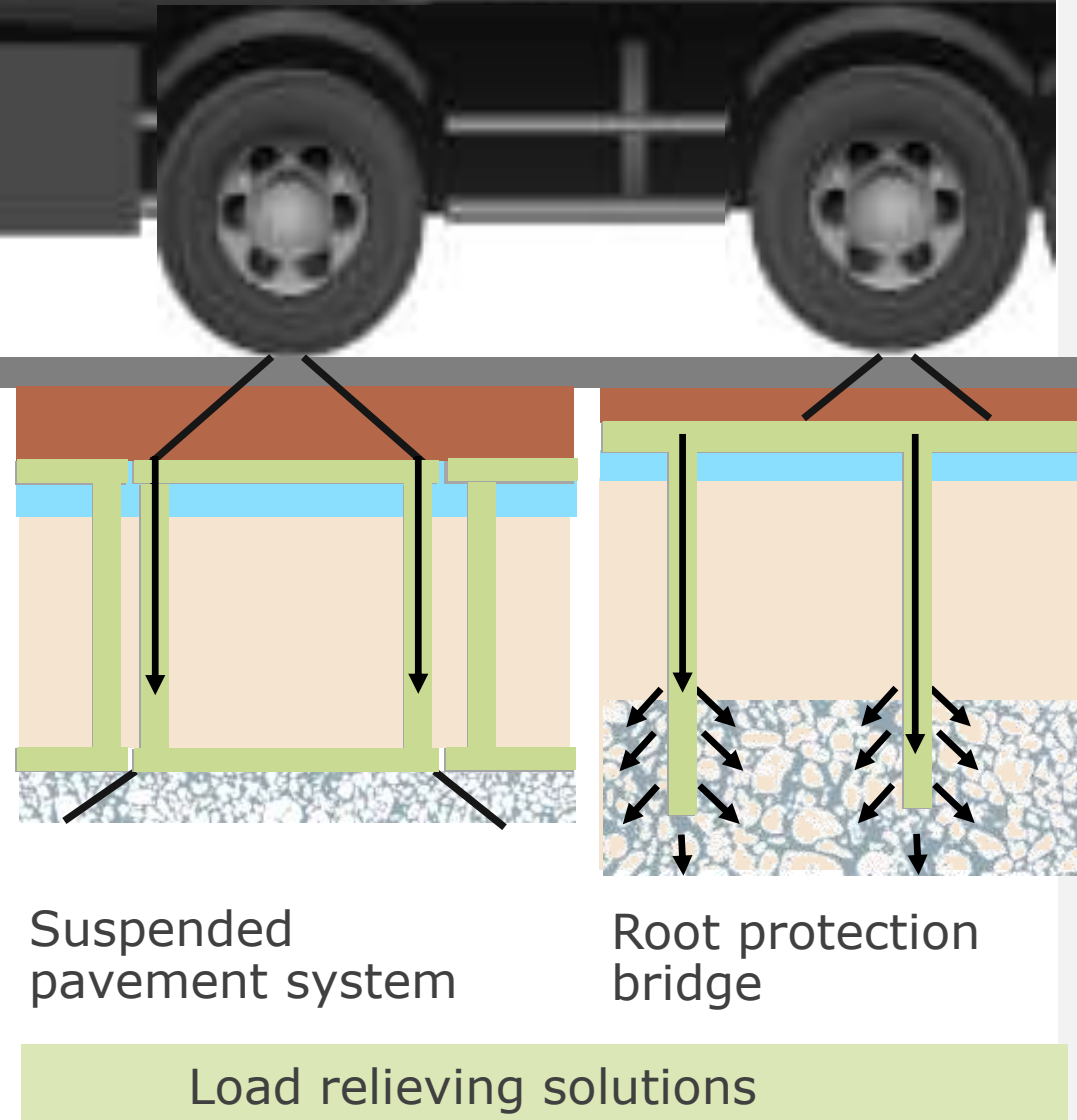
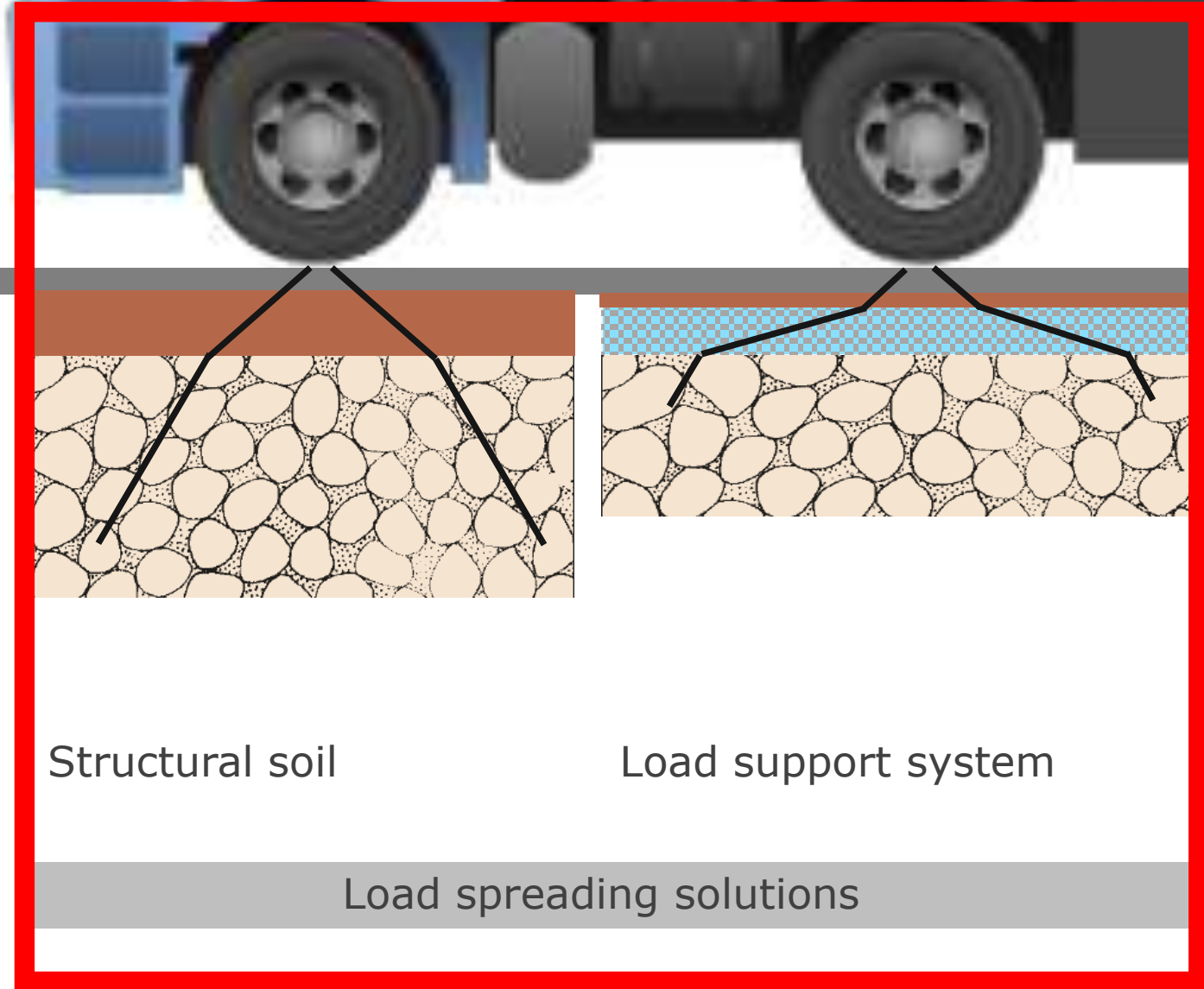
# Suspended pavement

- + high efficient soil volume
- + every soil can be used within
- + intergration of utilities possible
- + no root heave
  
- Load bearing capacity  
(not underneath roots >30 km/h)
- Room to work around

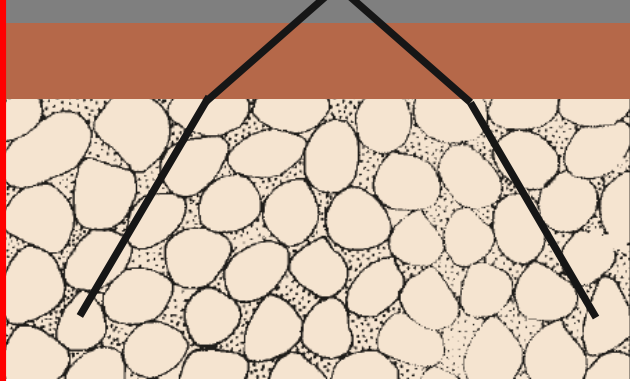
Depending on system

- + modules adaptable to underground obstacles
- + Water retention

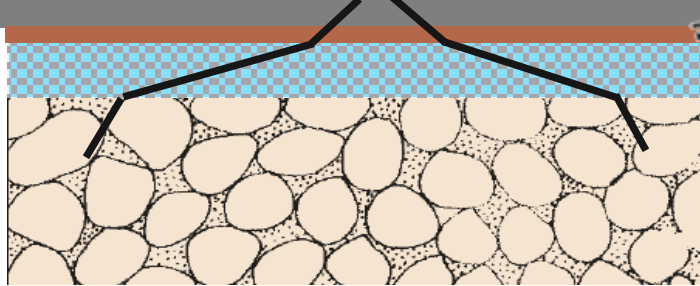
# main approaches



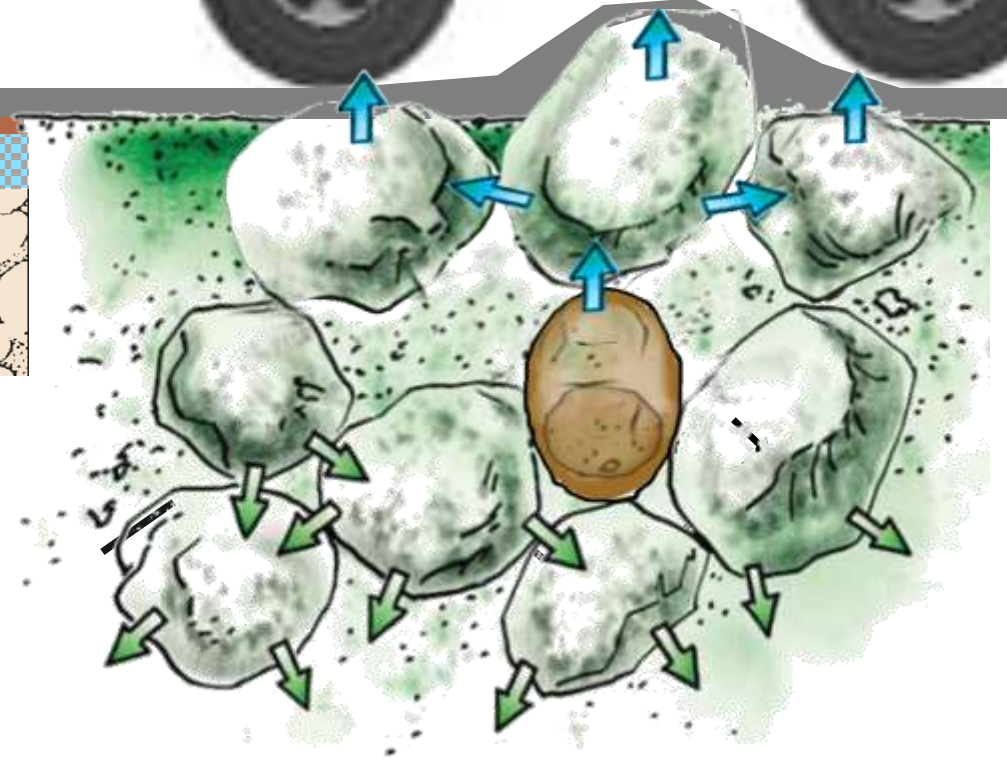
# main approaches



Structural soil



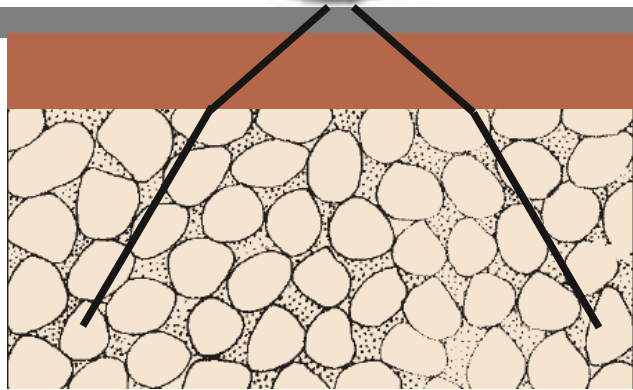
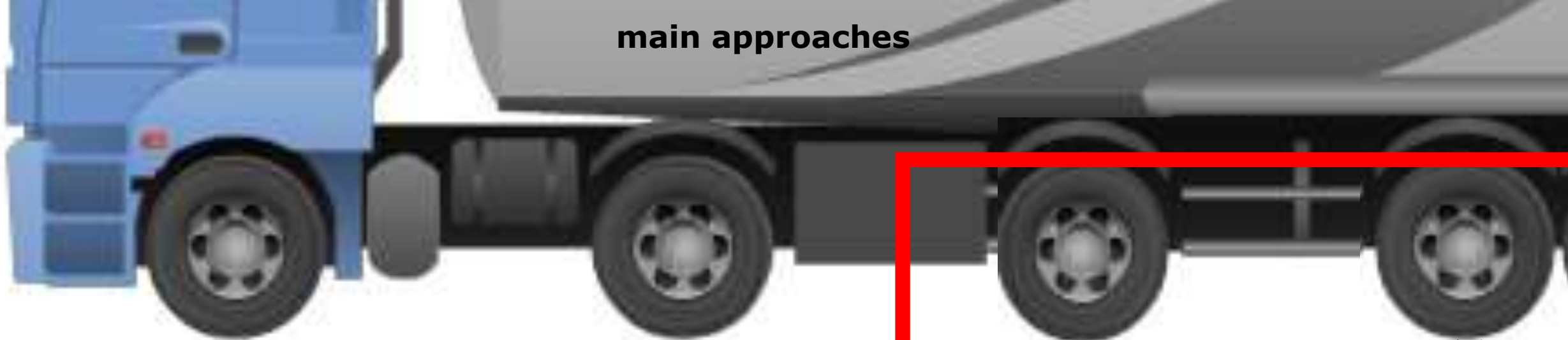
Load support system



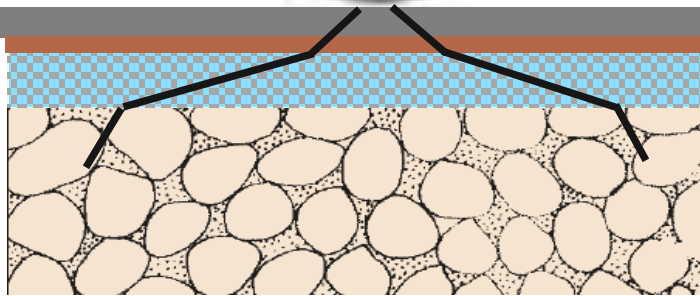
postponement of root heave

Load spreading solutions

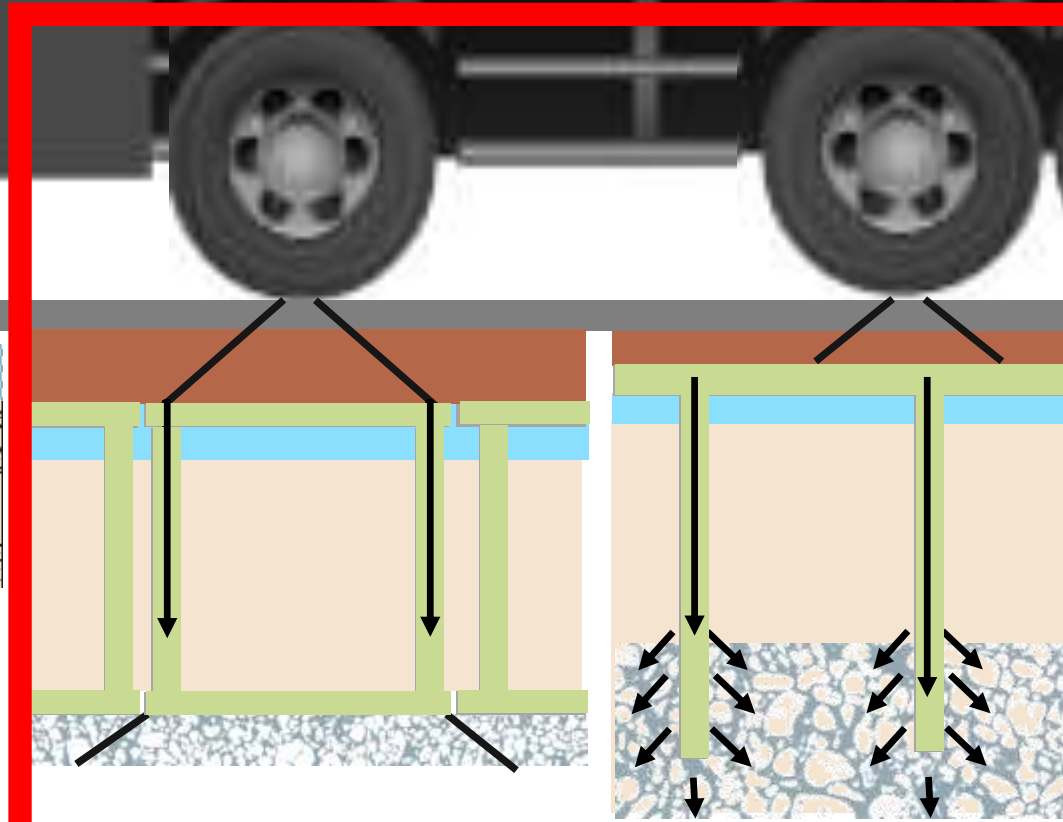
# main approaches



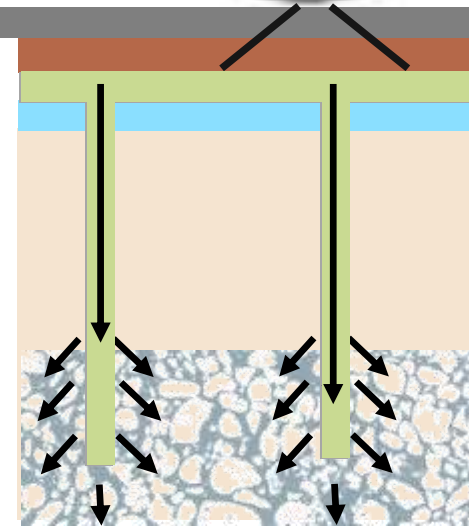
Structural soil



Load support system



Suspended pavement system

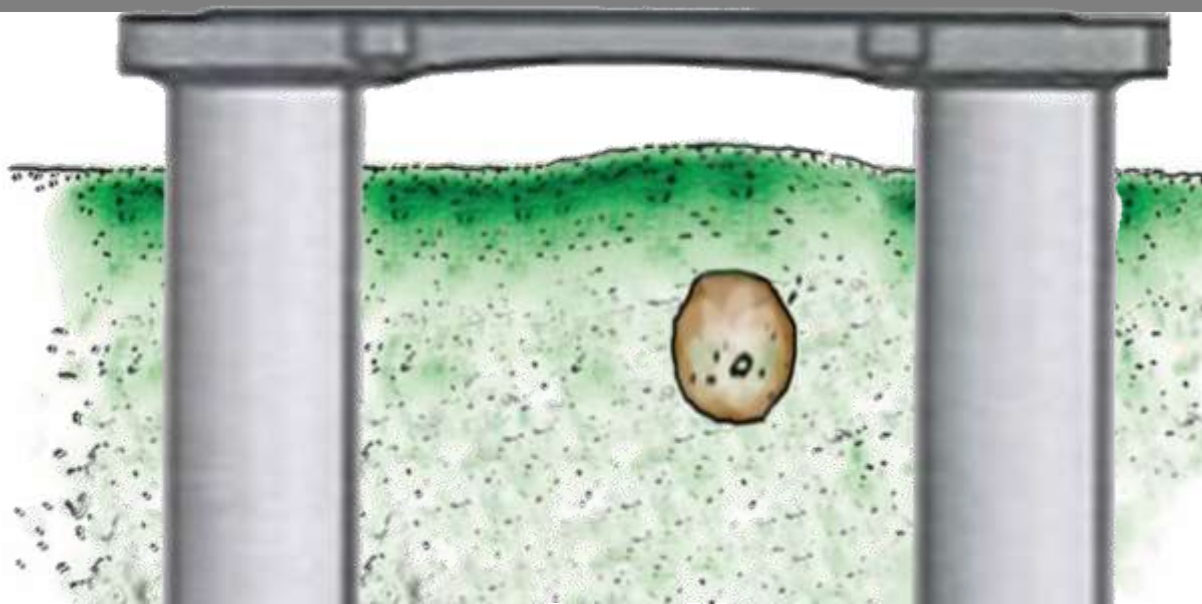
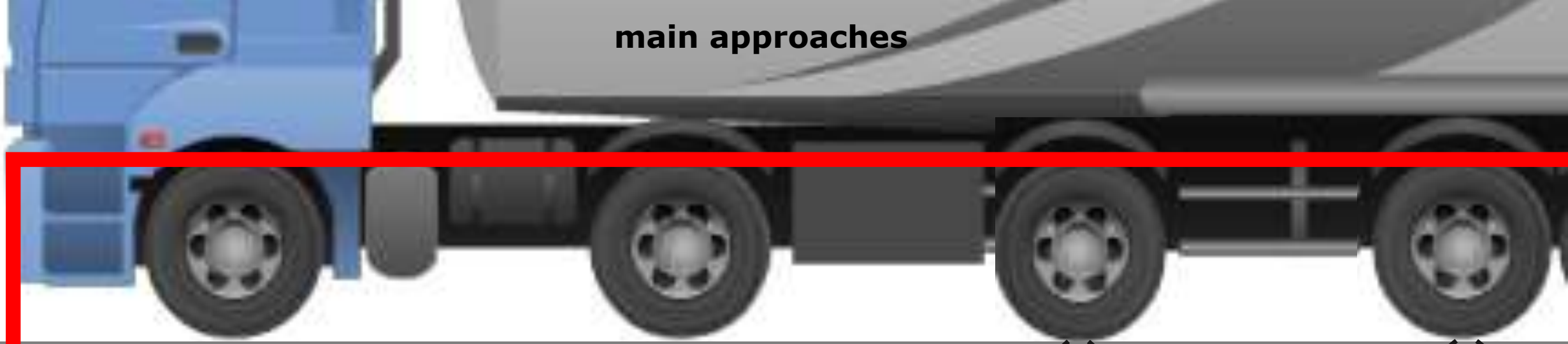


Root protection bridge

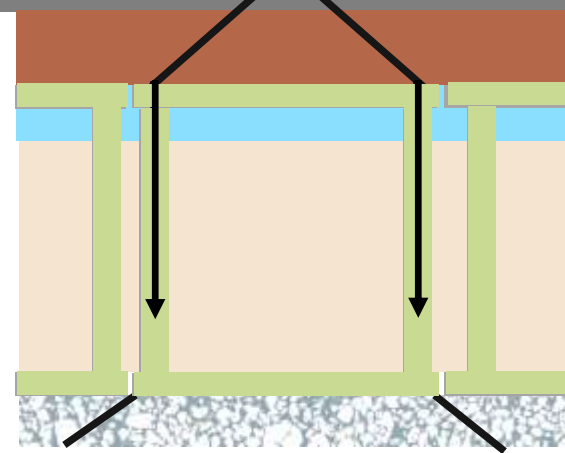
Load spreading solutions

Load relieving solutions

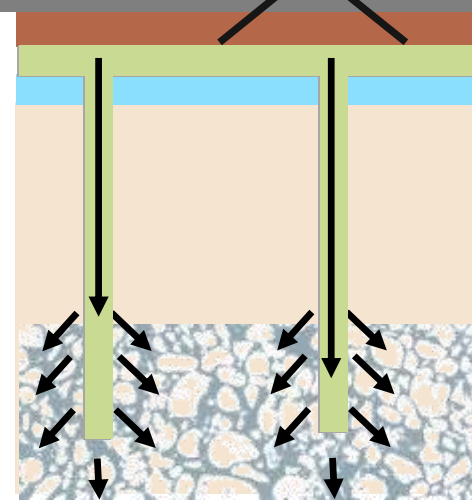
# main approaches



Root heave excluded



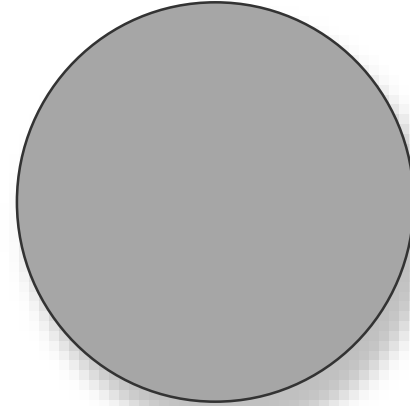
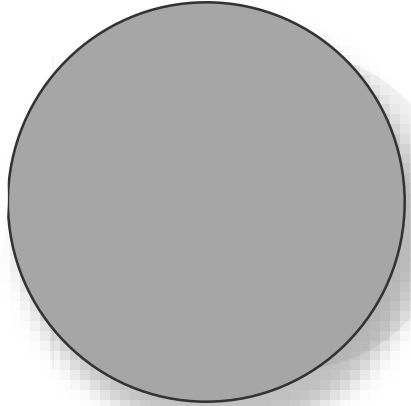
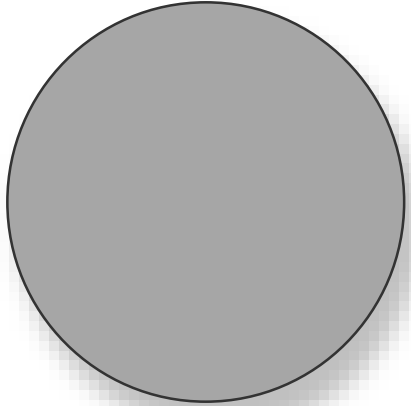
Suspended pavement system



Root protection bridge

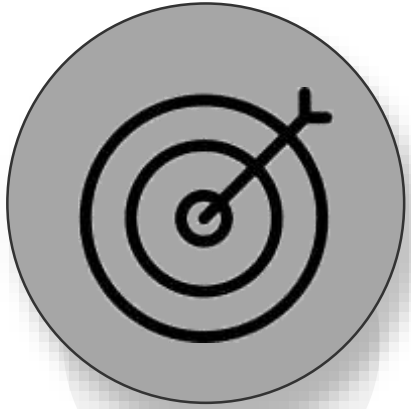
Load relieving solutions

# What is the best urban treeplanting solutions ?





# What is the best urban treeplanting solutions ?



## Targets/goals

- Healthy treegrowth
- Load capacity
- Water retention (pollution uptake)
- How much space you have



## Budgets

- Budget
- Investment
- Value of trees



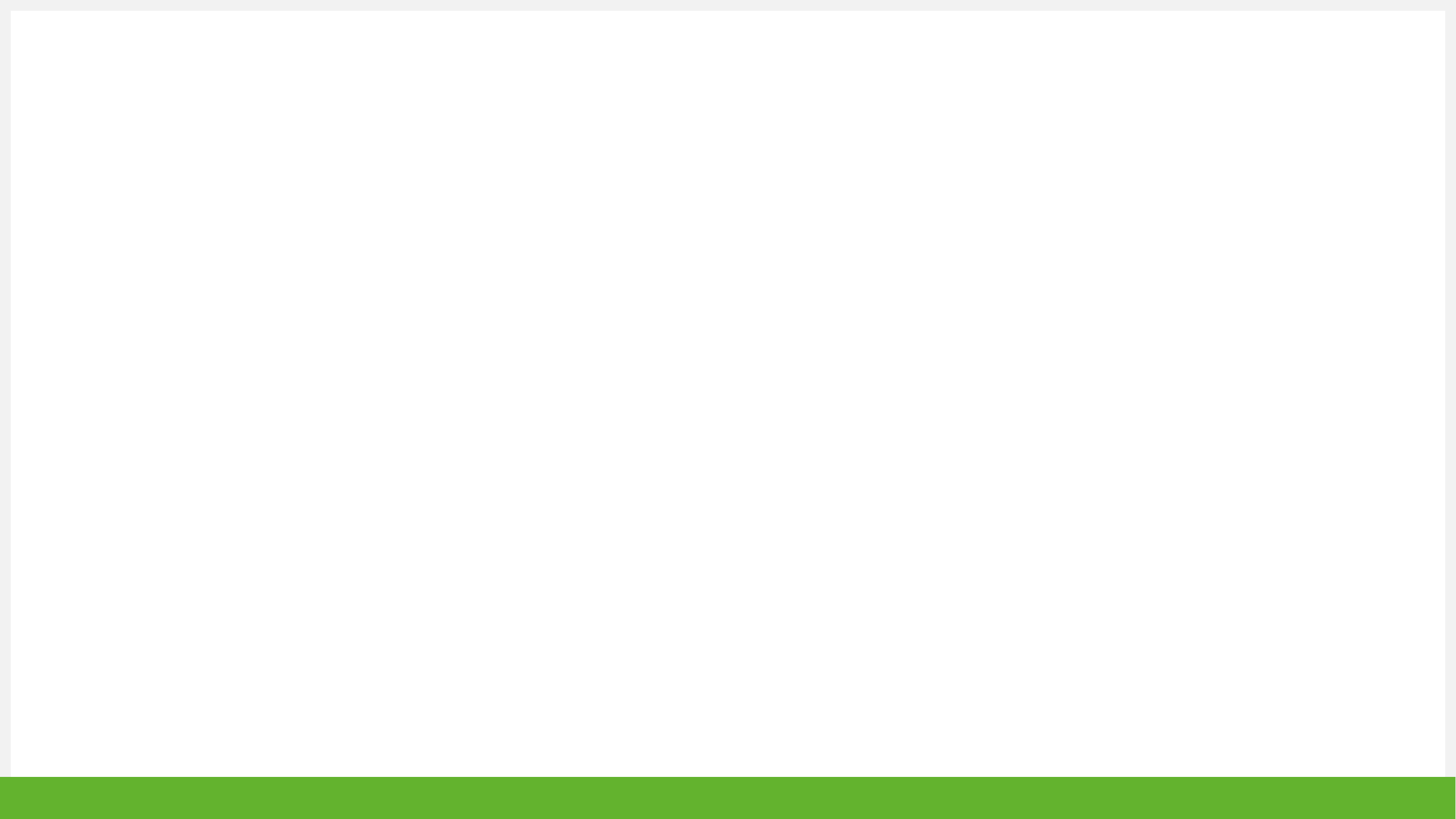
## Expectations

- Maintenance (rootheave)
- Utilities yes or no
- How much space you have

**Its depending on parameters that differ per project.**

**But all is better than doing nothing at all.**

**Urban tree planting system is just one part of the puzzle.**





Rain water collected inside airtayer,  
Saturation of the soil



Rain water collected inside airtayer,  
Saturation of the soil

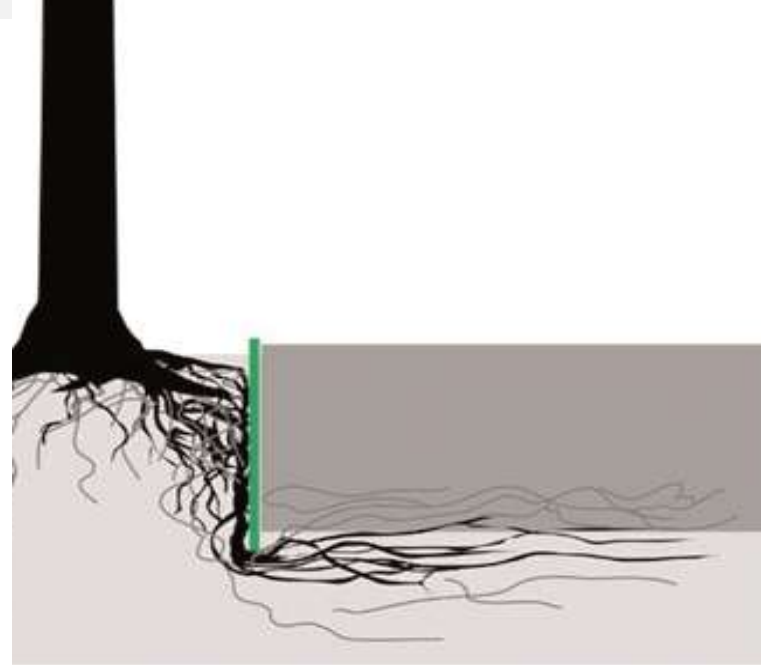
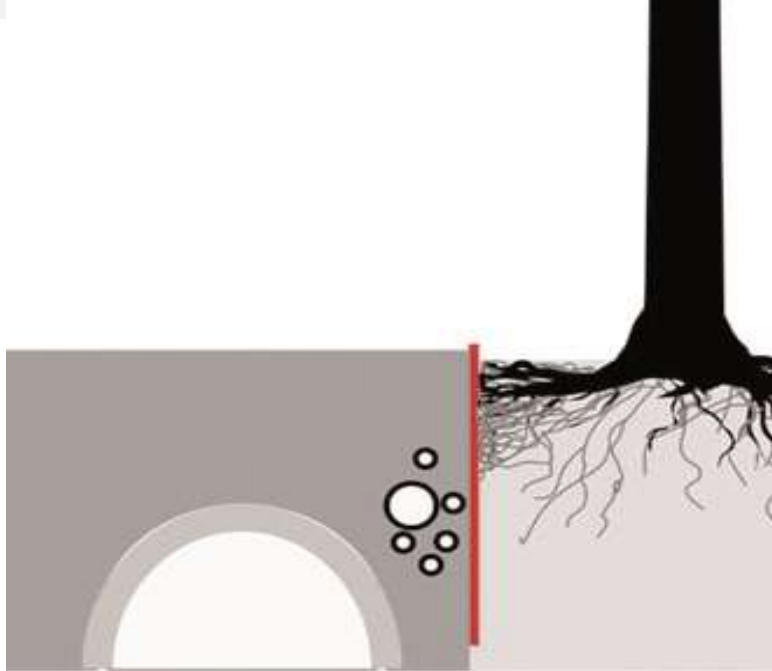
Overflow in waterstorage tank



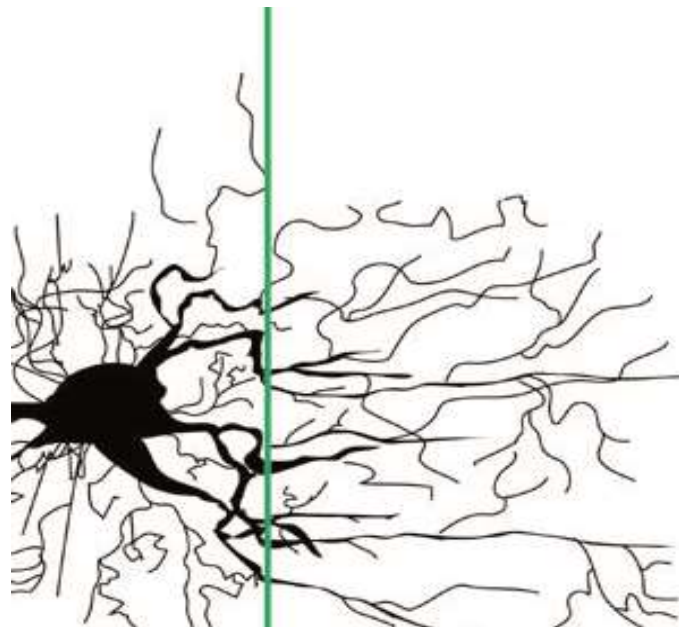
Rain water collected inside airtayer,  
Saturation of the soil

Overflow in waterstorage tank

During dry weather water is  
availabe for the tree



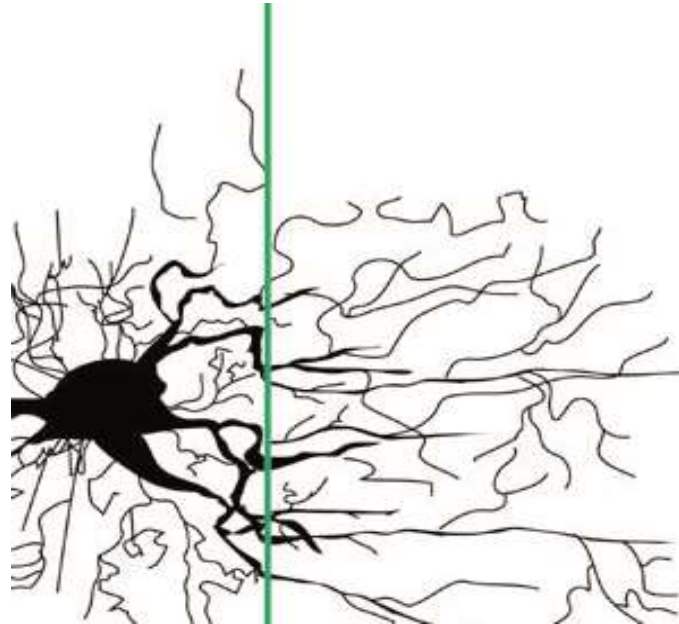
**ROOTBARRIER**



**TREEROOTGUIDE**



**ROOTBARRIER**



**TREEROOTGUIDE**