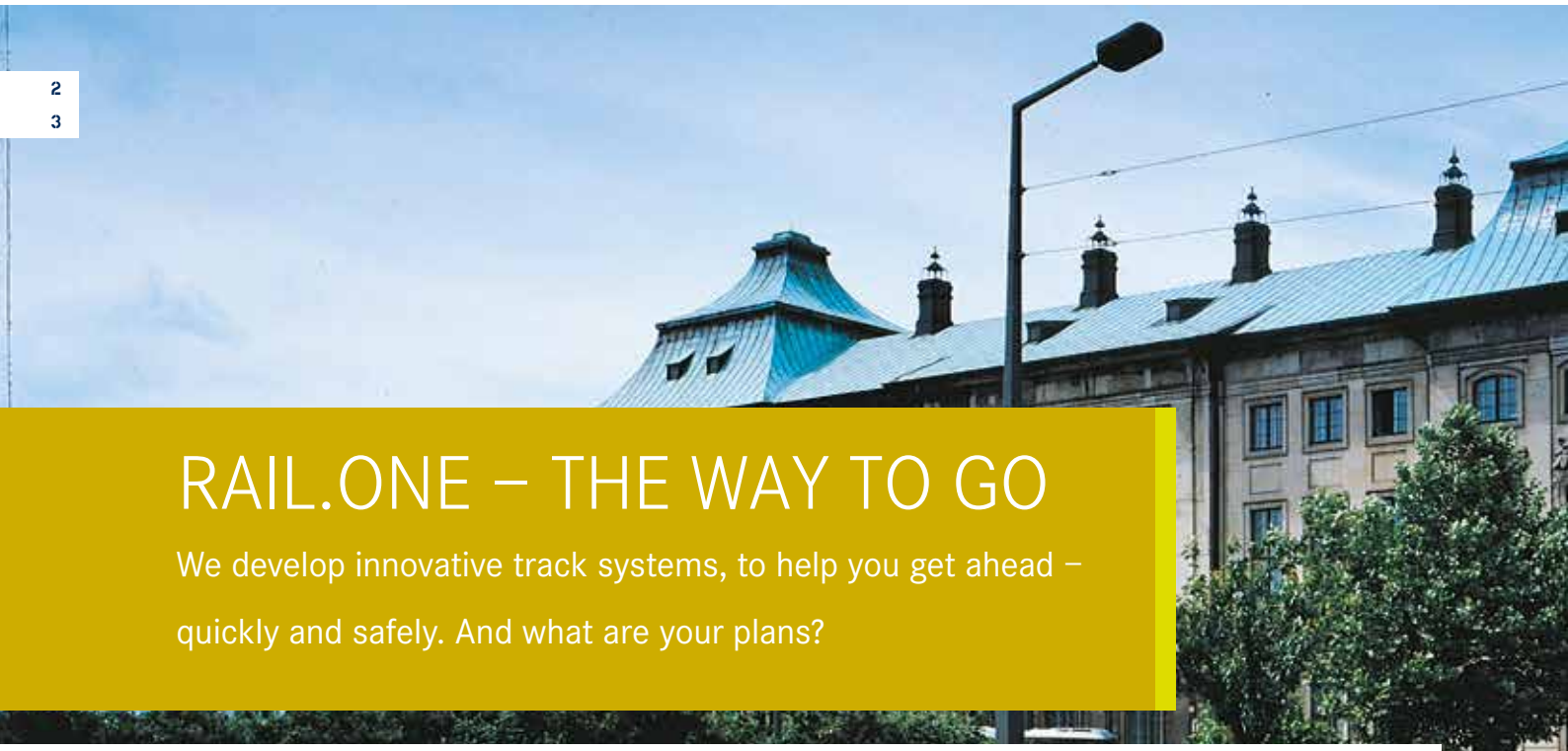
RAIL.ONE
The way to go.

ATD-G AND RHEDA CITY GREEN
THE GREEN TRACKS FOR URBAN TRANSIT



RAIL.ONE – THE WAY TO GO

We develop innovative track systems, to help you get ahead – quickly and safely. And what are your plans?

YOUR EYES SHOULD ENJOY TRAVEL, TOO

This is particularly true for mass rapid transit, where millions of people are under way by MRT, day in and day out. Effectively functioning mass transit is the heart of any city. In this sensitive zone of modern urban life, aesthetics are also gaining in importance, in addition to functionality and engineering. Track systems are frequently designed from a purely technical point of view, and too often represent a foreign body in the urban landscape. Development of the RAIL.ONE "Green Track", however, makes a much more pleasant appearance possible through improved integration of tracks into the urban landscape. Additional vegetated surfaces beautify the entire urban landscape, and allow use of the track area as a design element. At the same time, the municipal environmental balance benefits from this type of track system, as the "Green Track" improves air, soil, and groundwater conditions. The structured surface of the green space, and the advanced elastic rail fastening common to modern tracks, result in more favourable airborne-sound emission and structure-borne noise in comparison to conventional track models within the city. Nice for people, and nice for the environment.

ENVIRONMENTAL AND ECONOMIC TRACK TECHNOLOGY

RAIL.ONE offers a variety of ballastless track systems as "Green Track": ATD-G and RHEDA CITY GREEN. Both systems are specially designed for public passenger light rail. The systems are especially well-suited for trams and light rail in the inner city. The characteristic feature of the ATD-G system is the asphalt layer with concrete bi-block sleepers laid directly on top. The track panel is held in place by a lateral force base. The RHEDA CITY GREEN system is the green version of the RHEDA CITY ballastless track system. Here, too, modified bi-block sleepers with lattice girders are used. The monolithic structure and the low structural height guarantee a perfect rail position and a high degree of safety. The major advantage of both systems is an attractive visual impression along with favourable environmental characteristics. Both ATD-G and RHEDA CITY GREEN can be planted with grass or sedum.

The two designs are further detailed on the following pages.

ATD-G – THE “GREEN TRACK”

ATD-G is derived from the ATD system that has already proved successful in high-speed traffic applications for railways.

ATD-G STRUCTURAL TRACK DESIGN

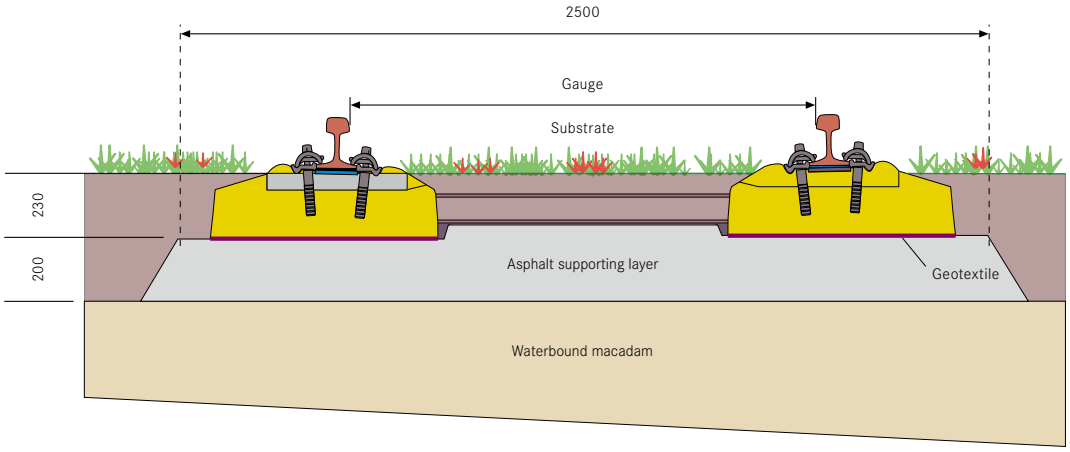
The track system ATD-G (which stands for Asphalt supporting layer for Track Direct support, Green) is a ballastless track system in which a cross-sleeper track panel, consisting of concrete bi-block sleepers and the connected rails, is directly installed onto an asphalt supporting layer with exact height tolerance. The modular principle used here enables effective derivation of solutions for the individual requirements of public transport authorities. The basis for this work is a uniform system structure for all elements of the track route: e.g., straight and curved through-track sections, curved track with cant, train stations, turnouts, transitions to other rail profiles, and crossings for pedestrians and vehicles.

THE MOST IMPORTANT ATD-G CHARACTERISTICS:

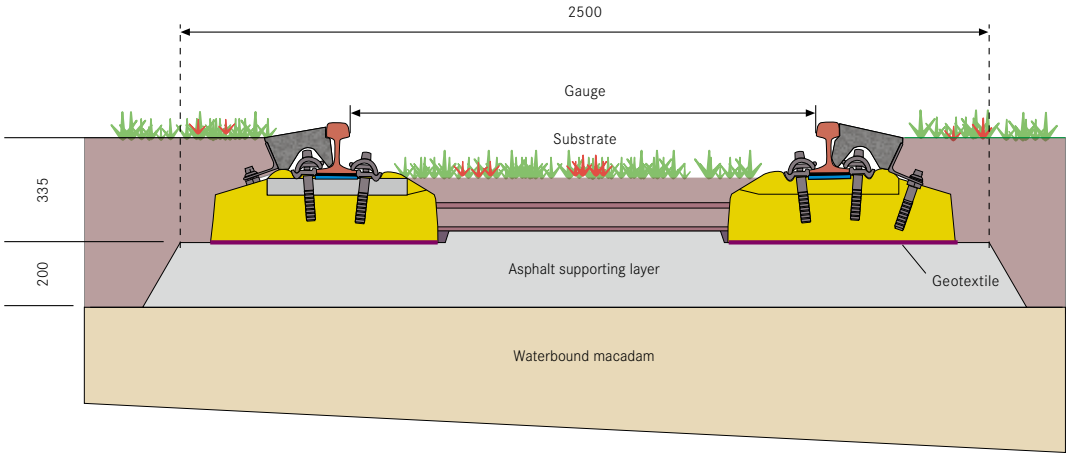
- Continuous track stability and long lifecycle
- Simple and transparent structure of the system
- Flexible layout possibilities
- Favourable installation by mechanized processes
- Short construction periods, with resulting short interruption of rail traffic
- Minimum interference with traffic flows during installation
- Low maintenance and therefore fewer traffic interruptions
- Easy cleaning
- Modular adaptation to various road construction types
- High resistance to corrosion caused by parasitic current

SYSTEM CROSS-SECTIONS

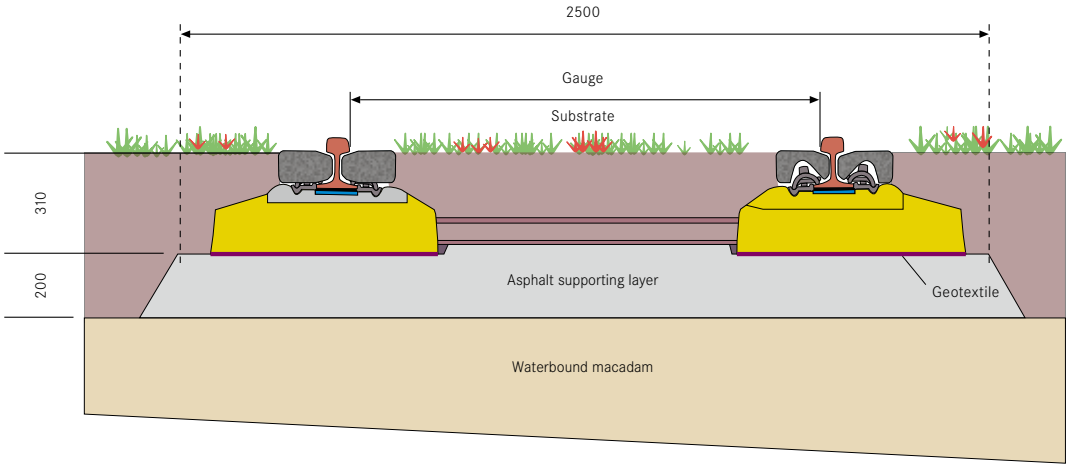
Low vegetation cover



Mixed vegetation cover



High vegetation cover



BASIC TRACK

ATD-G

Green rail ATD-G in operation

Sub-grade prepared for asphalt cover

Completed supporting asphalt (three layers),
with height exactness of ±2 mm, and with integrated lateral-force base support

REFERENCE PROJECTS

ATD-G: System overview

Each project is just as individual as the customer itself. The special circumstances at the construction site, and the customer's own requirements, are equally essential. Due to its flexible system structure, the ATD-G Green Track system has been a success in numerous cities.

Berlin Public Transport Authority (BVG)
In 1995 the Berlin Public Transport Authority (BVG) constructed a two-track pilot project featuring tracks installed flush, at sleeper height, with the street surface, and planted with sedum. The outstanding results obtained at this first location prompted the BVG in Berlin to stipulate that the ATD-G model would be the standard form of implementation in its network for future projects. After these successful trials, the BVG implemented over 22,000 metres of ATD-G Green Track in several projects. In the meantime, the BVG has, over several development stages, raised the vegetation of the track system to the level of the rail head.

Hanover Public Transport Authority (üstra)
As part of its infrastructure improvements for the EXPO2000 World's Fair in Hanover, the municipal public transport authority implemented approx. 8,000 metres of ATD-G on the suburban passenger line to the EXPO site. The vegetation used on the Green Track was in the form of sedum mats and seed-planted turf, both up to sleeper height. Concrete slabs installed in the spaces between the sleepers prevent the vegetation from covering the rails. In spite of heavy usage of the track facilities the position and the height of the rails remain stable.

Cologne Public Transport Authority (KVB AG)
In April 2003, the Green Track was put into operation on the tram line running down the Cologne street Markgrafenstrasse. The system implemented for the 2,000-metre tram line was the ATD-G, with sedum planted up to sleeper height. As there were more stringent requirements for preventing vibration and airborne noise, the E 14 Vossloh Fastening System was used on this project.

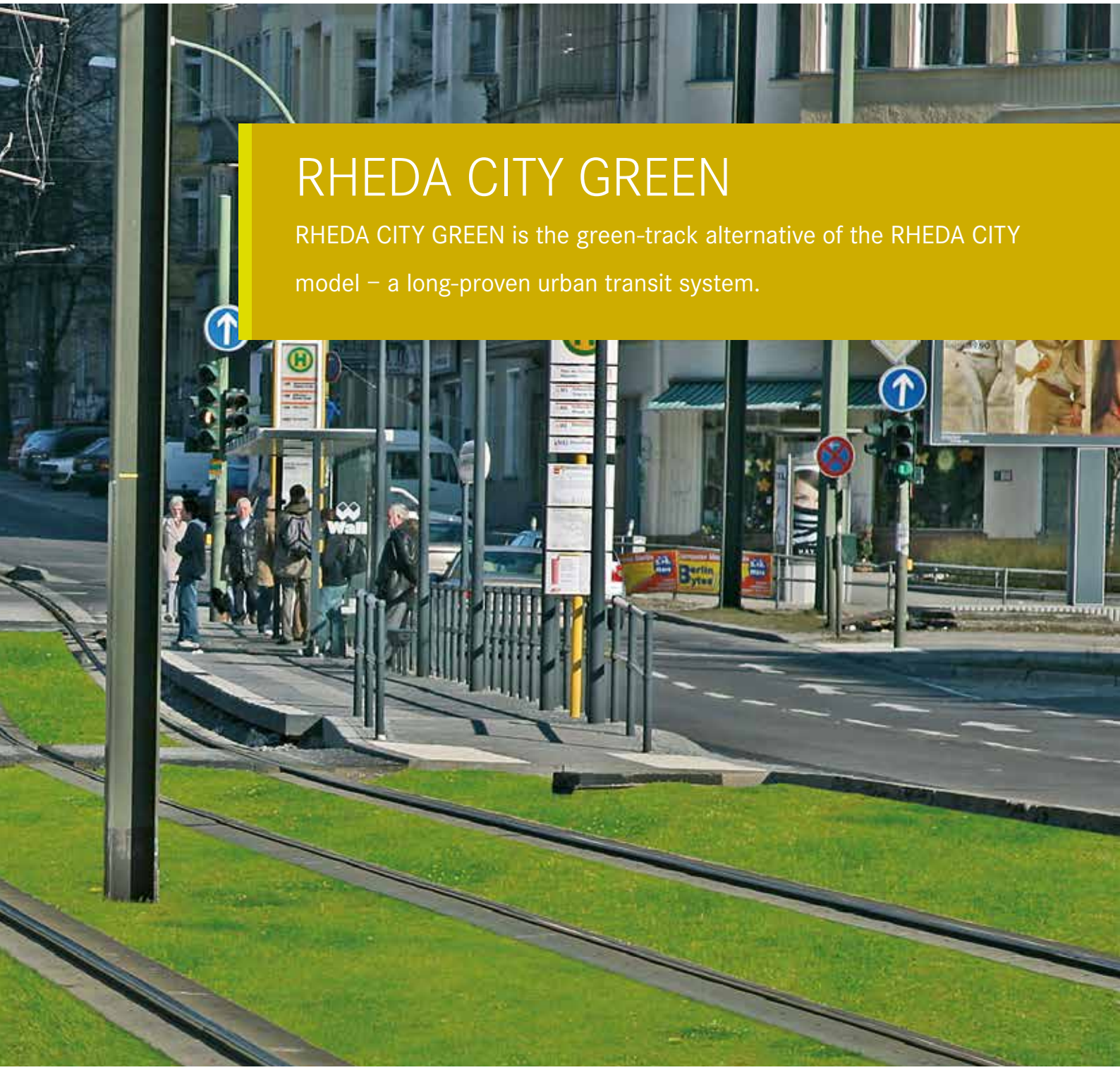
Dresden Public Transport Authority (DVB AG)
In 1996 the Dresden Public Transport Authority installed an attractive turf track in two construction phases, over a total length of 1,400 metres. The turf was installed in the form of rolled sod, with grass up to the level of the rail head. Special elements that fill the space between the rail head and rail flange provide insulation and prevent the turf from growing up to the rail. Both of these measures reduce airborne noise emissions to low levels. In order to allow rescue vehicles to use part of the section of the track, the track panel was filled with a mixture of mineral material used for drainage, and plastic honeycomb material was installed in the turf area. Since being in operation, the track is still in outstanding condition, and satisfies the client's stringent requirements for track-position stability, noise-emission reduction, and vegetation cover.

Placing the sleepers on the completed asphalt supporting layer

Installed and properly aligned track panels

MODERN ECOLOGY PLUS ADVANCED TECHNOLOGY

For the RHEDA CITY GREEN model, modified bi-block sleepers with lattice girders are concreted into a compact concrete slab. A cover with turf or sedum gives an attractive optical impression. This system combines the functional and safety advantages of an absolutely stable track position with the cost-efficiency of almost no maintenance. Projects with “green rails” have already been implemented in several German cities, such as Cologne, Düsseldorf, Karlsruhe, Mannheim, Hanover, and Berlin. The ballastless track system is also used in major European cities such as The Hague (Netherlands), Edinburgh (Scotland), Reinach (Switzerland), Warsaw and Sosnowiec (both Poland).



RHEDA CITY GREEN

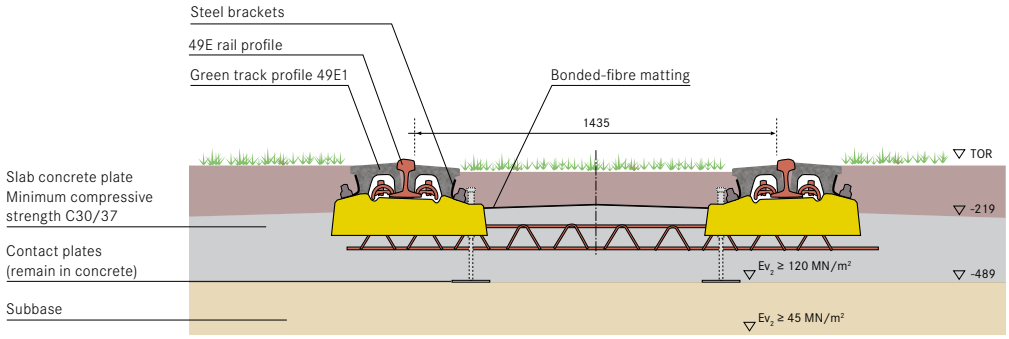
RHEDA CITY GREEN is the green-track alternative of the RHEDA CITY model – a long-proven urban transit system.

THE MOST IMPORTANT RHEDA CITY GREEN CHARACTERISTICS:

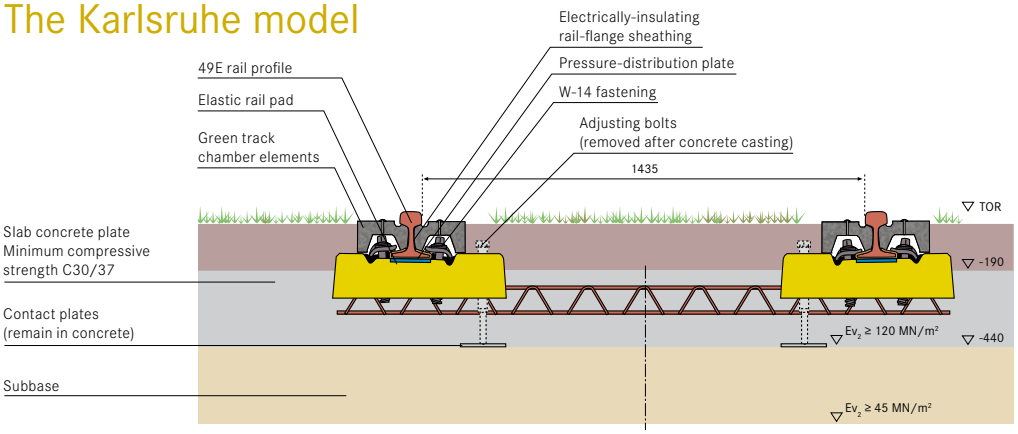
- Simple, transparent system structure with high installation performance
- Elimination of gauge tie bars
- Great precision of gauge and track geometry from the cross sleeper, resulting in perfect rail positioning
- Permanent friction-anchoring of the track panel
- Defined elasticity of the track, by employment of pre-assembled components
- Great levels of safety and long service life
- Green tracks support a modern and attractive cityscape:
  - Reduced noise emissions and vibrations
  - Incidental surface water is stored and returned to the environment through evaporation

SYSTEM CROSS-SECTIONS

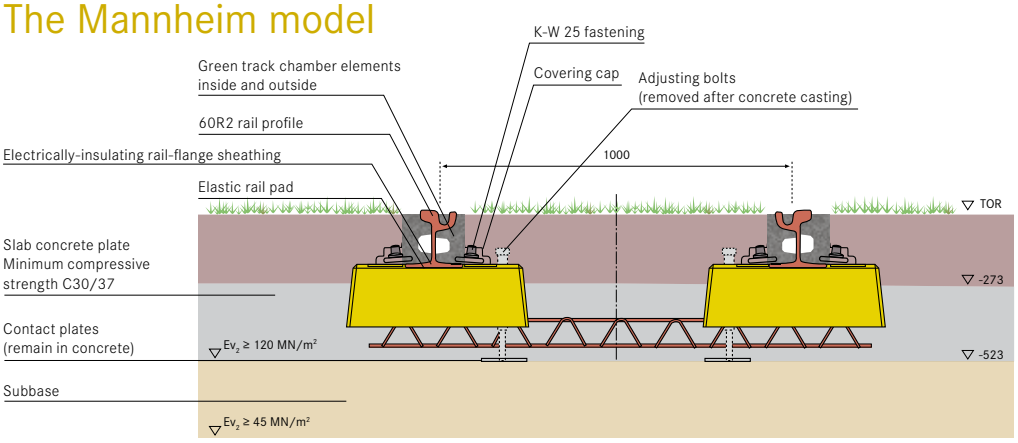
The Berlin model



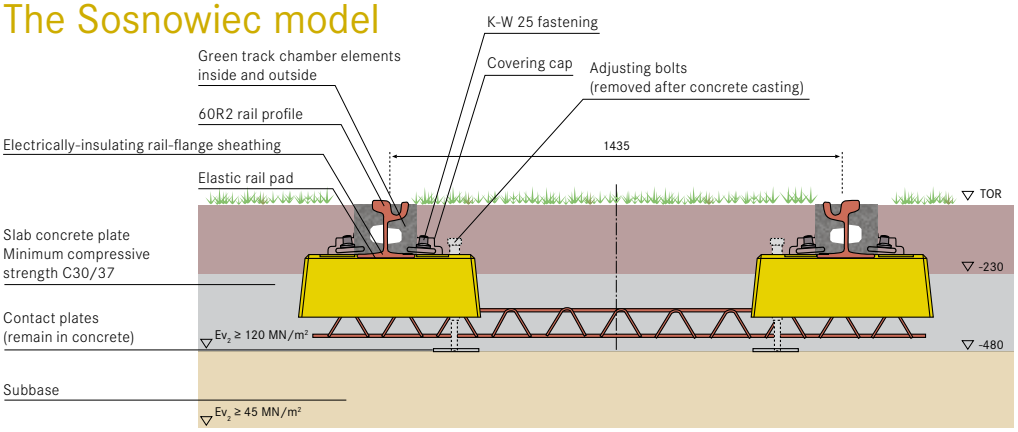
The Karlsruhe model



The Mannheim model



The Sosnowiec model



BASIC TRACK

RHEDA CITY GREEN

Completed track

Positioning of the bi-block sleepers

Attachment of the rail-flange sheathing

Completely assembled and aligned track panels

Concreting of the track panels

Concreted track with green track chamber elements and level crossing

REFERENCE PROJECTS

RHEDA CITY GREEN: System overview national

The green version of the proven RHEDA CITY system is successfully in use in many cities in Germany and Europe. Every version is tailored to the needs of the transport company and local authority.

Berliner Verkehrsbetriebe (BVG)
The tram system in the city of Berlin has used the RHEDA CITY GREEN version since 2004. To date, over 36 kilometres of track provide more green space in the city, thus improving the municipal environmental balance. The NBS-G version was developed especially for the Berlin Transport Authority.

rnv, Rhine-Neckar Traffic GmbH
RHEDA CITY GREEN has been used for the rails of the rnv in Mannheim, Heidelberg, Ludwigshafen, and surroundings since 2006. Jointly with rnv, the design of the structural height has been optimised in several steps. Today, the rnv travels on approximately ten kilometres of RHEDA CITY GREEN.

VBK, Karlsruhe Transport Authority GmbH
RHEDA CITY GREEN was first used in the construction of the Durlach-Aue/Wolfartsweier tram line. Since 2003, over ten kilometres of RHEDA CITY GREEN have been laid here and in other projects.

REFERENCE PROJECTS

RHEDA CITY GREEN: System overview international

Projects in Poland

Tramwaje Śląskie S. A. is the operator of the Silesian tram line. As part of the renewal of the tram network, five kilometres of grooved turf rail track of the RHEDA CITY system was laid in 2013 in Sosnowiec. Furthermore, since 2011 around 4.5 kilometres of the turf rail track were laid for the Tramwaje Warszawskie of the Polish capital city of Warsaw.

The Hague, Netherlands

From 2006 to 2007 around 1.2 kilometres of grooved turf rail track was laid in The Hague. In addition, the turnouts installed were also from the RHEDA CITY system. Along with delivery of the railway system, RAIL.ONE was also responsible for the system monitoring.

Edinburgh, Scotland

The Edinburgh Tram Link – one of the largest infrastructure projects in Scotland – connects the airport to the city centre. In the selection of the railway system, along with technical reliability ecological aspects also played an important role: special requirements for environmental protection had to be taken into account, since some sections run along a “green belt”. The turf rail track should also reduce noise emissions and ensure optimal drainage of rain water. To meet these requirements, the RHEDA CITY GREEN system was used on more than three kilometres of track. In addition, a covered variant of RHEDA CITY was installed on more than 15 kilometres of track.

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Member of PCM Group of Industries

Green Tram Tracks

The Advantages of Implementing Vegetation Systems in Tram Tracks

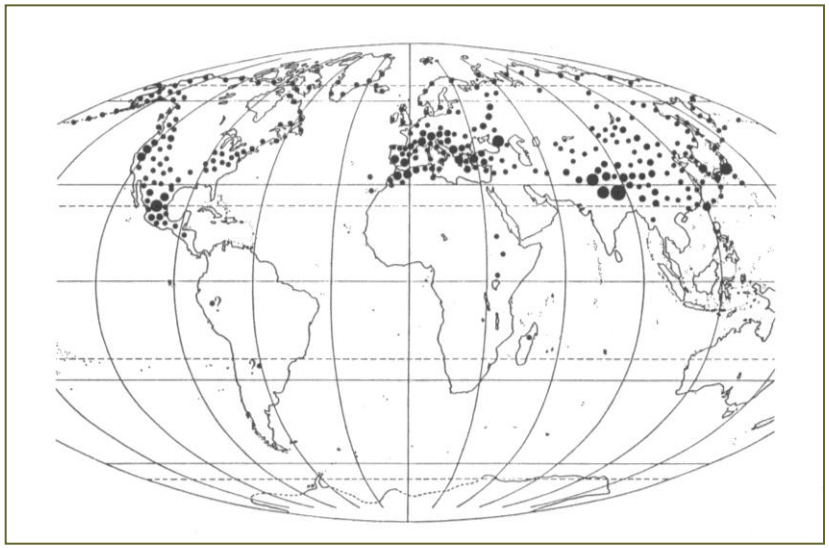
Institute for Agricultural and Urban Projects at the Humboldt-University, Berlin

Dipl.-Ing. agr. Hendrikje Schreiter 24 June 2010, Prague

1 Sedum

- Sedum: genus of 500 species
- Distribution: Northern hemisphere,
- 3 contrasting areas especially rich in Sedum:

  Mexico, Mediterranean Sea, Himalayan Mountains

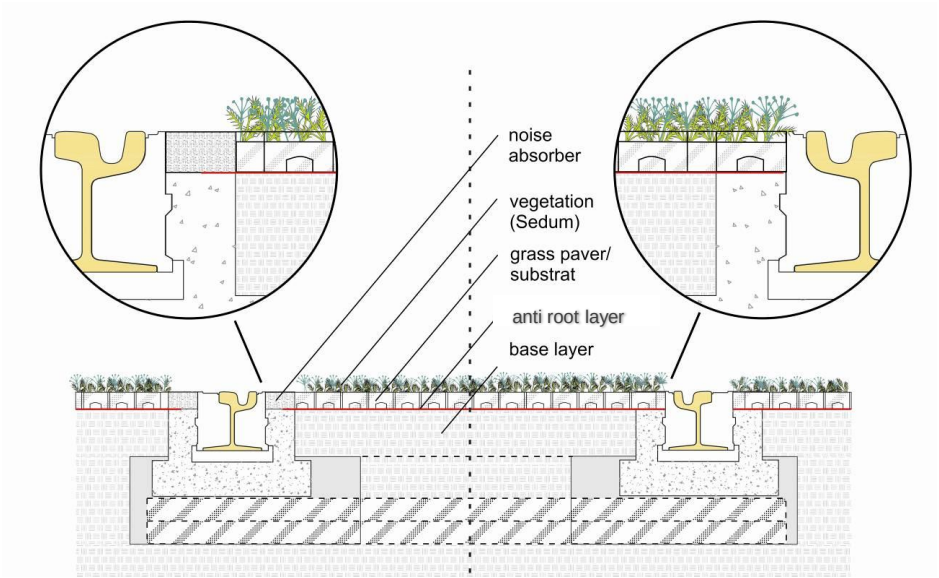


Natural Sedum distribution (STEPHENSON 1999)

Sedum track, Berlin, Prenzlauer Allee, June 2009

- Adaption to track condition and local condition
- Stray current (EN 50122-2)
- Reduction of life cycle costs, which also means low maintenance
- Optic all year round
- Accessibility for snow clearing
- Drainable but water retaining
- Reduction of noise reflection
- Drivable for emergency vehicles

Track design for test site Brussels



Special absorber: Drain concrete

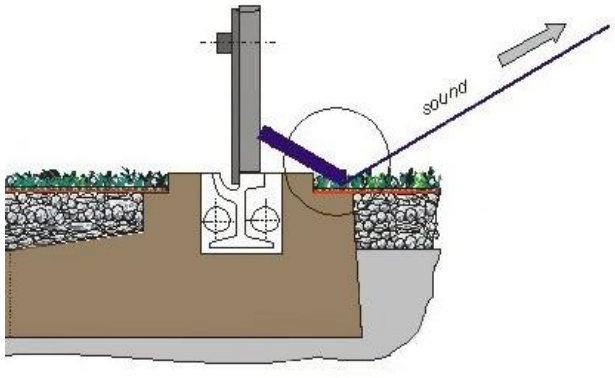
Special absorber: Porous rubber

Grass paver up to rubber jacket

- Fatigue test
  - simulated more than 34 years fatigue, at three wheel crossings a day

Drain concrete test body at STUVA fatigue laboratory, after testing

- Main noise source: contact of rail and wheel
- Reduction of reverberant surfaces
- Noise absorption at tor-level up to 2 - 4 dB (A) vs. ballasted track
- Comparison of green track materials: noise absorption in impedance tube
- Substrate, Sedum, artificial grass, cavity elements, absorber, grass paver



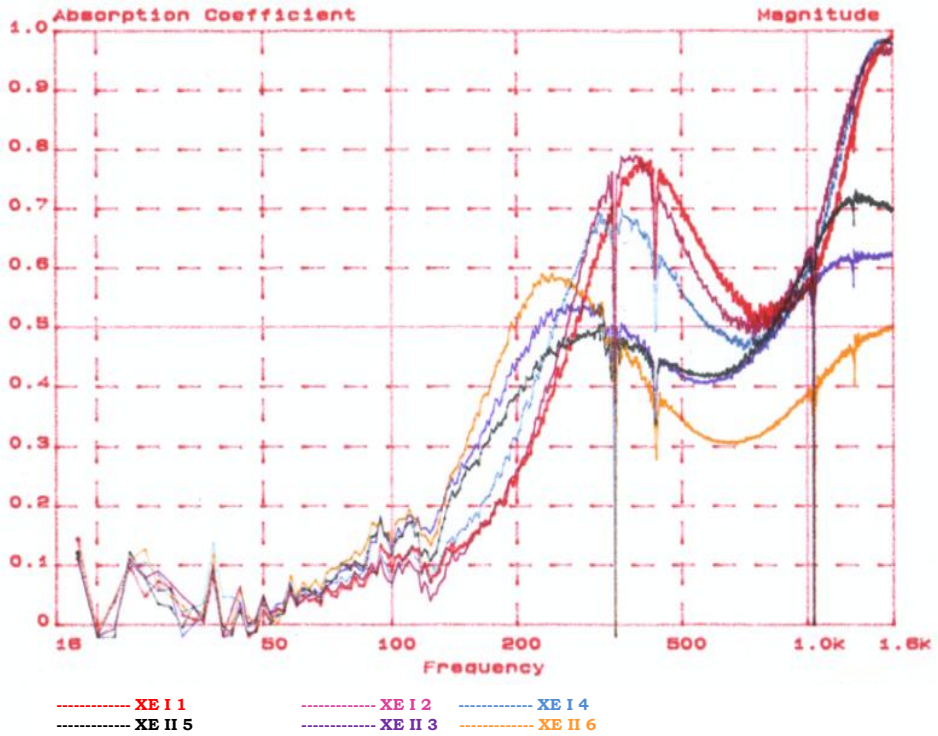
Rail-wheel contact

Impedance tube(Brüel & Kjær, type 4206)

Some test materials

- Absorption
  between 500 - 1000 Hz:
  vegetation & artificial grass > substrate > drainasphalt and porous rubber mat > cavity elements

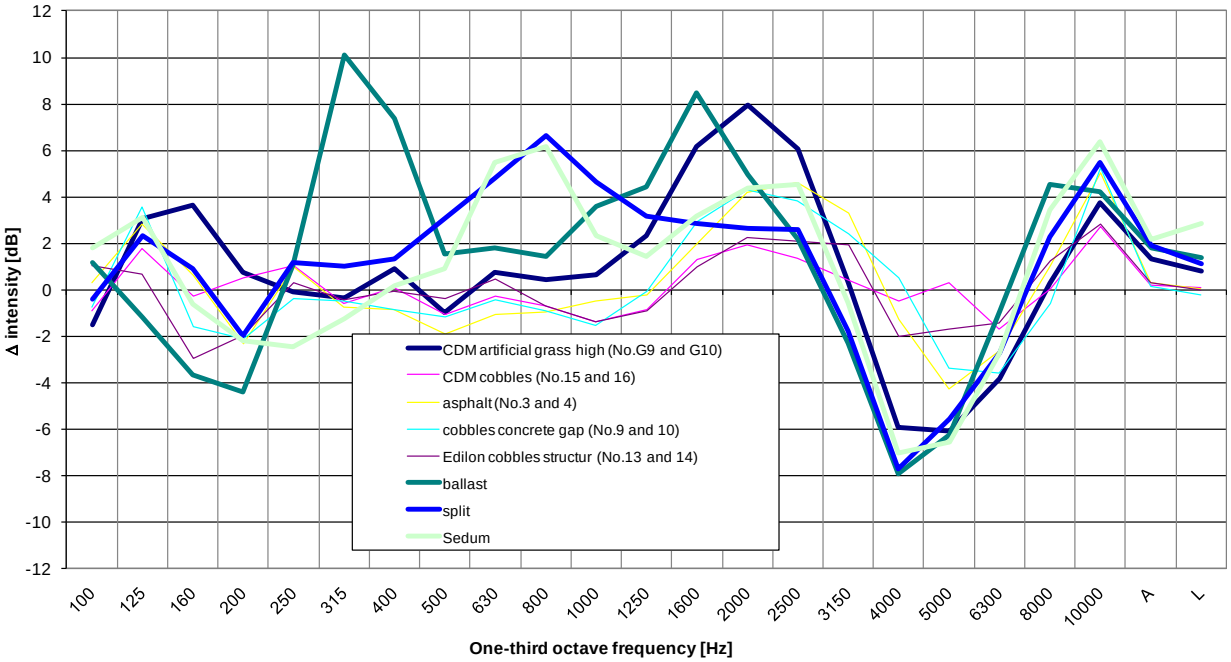
- Used materials with best absorption properties for track design



Comparison of two substrates: Xeroterr I (0/12) and Xeroterr II (0/8)

α(Xeroterr I) > α(Xeroterr II)

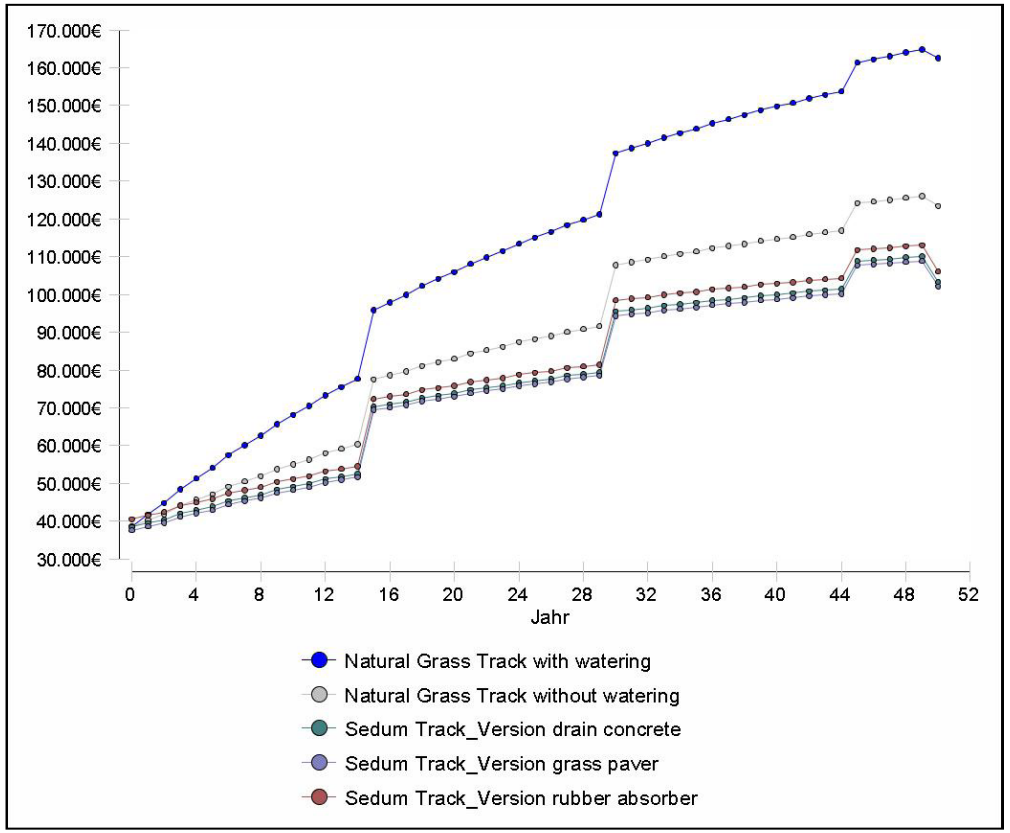
- Comparison of test bodies for sound absorption



Sound measurements, STUVA lab

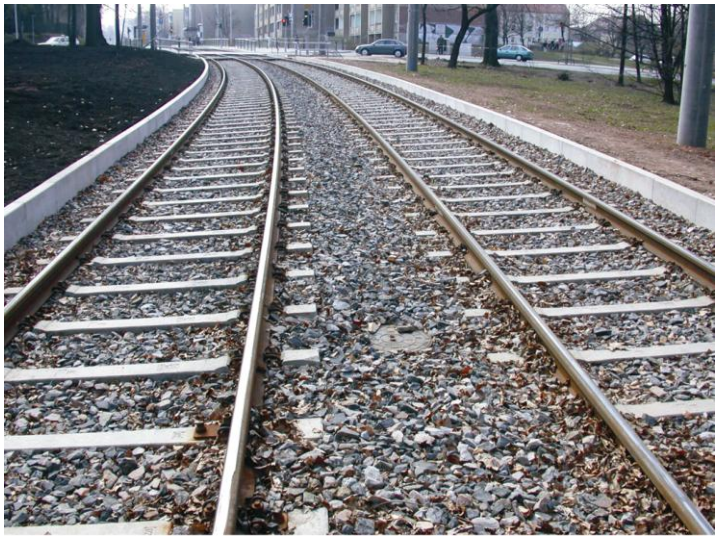
Results of sound absorption measurements on test bodies: means of lower level (stimulation pink noise, measurement of sound intensity, difference levels to “unruffled concrete no. 1 and 2)

- Sedum =extensive naturation system
- Low maintenance needs (fertilzation)
- Compensating measures for surface sealing would cease to apply



Cumulative LCC of the canditates over 50 years

- Tram tracks are part of the cityscape
- Aesthetic aspect
- Green space is brought into cities, natural and calm atmosphere.
- Some Sedum varieties are evergreen
- Habitat for innumerable insects and other invertebrates

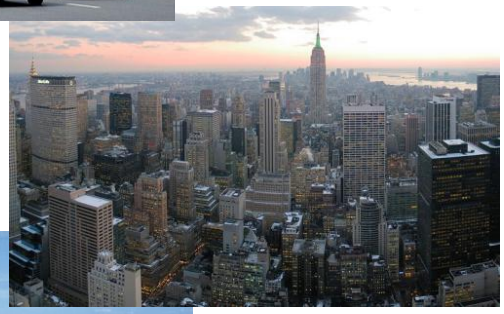


Chemnitz, Goethestraße before naturation

Chemnitz, Goethestraße after naturation

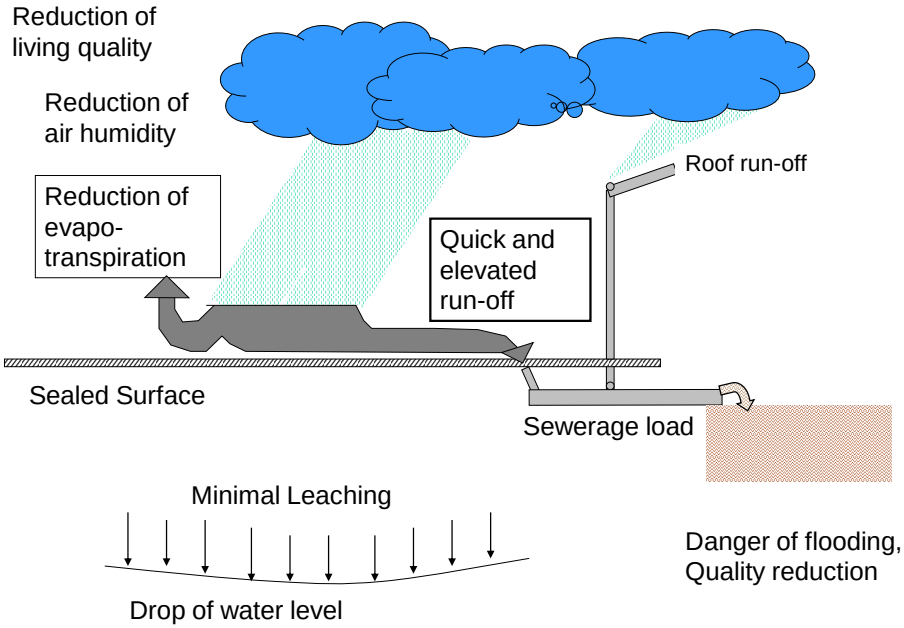
- Problems in urban agglomerations

www.inmoskau.de/blog/wp-content/**moscow-city**-moskau-th.jpg



www.alleangebote.com/reisetipps/wp-content/uploads/2009/05/**new_york_city**.jpg

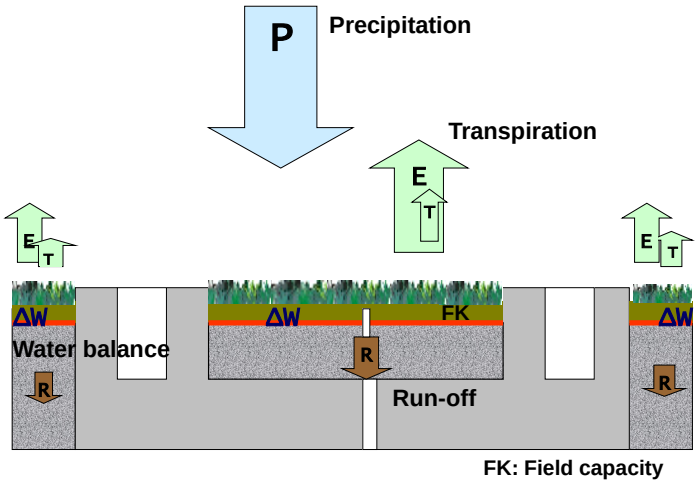
www.laits.utexas.edu/**berlin**/images/buildings/05PotsdamerPlatz/c215_PotsdamerPlatz.jpg



Negative impacts on urban water balance due to surface sealing
(modified, from ILS 1993)

Implementation of vegetation systems:

greened area = unsealed or partly unsealed



$$P = ET + R + \Delta W$$

Elements of the water balance in a tram track naturation

P= Precipitation;
ET= Evaporation and Transpiration;
R= Run-off;
ΔW=Water balance in the vegetations system [mm or l/m²];
FK = field capacity

Barcelona www.tramvia.org

7 Water balance

- Extensive vegetation systems: retain 50 % of precipitation.
- Intensive vegetation systems: retain 70 % up to 100 %

- Germany (IASP 2009):

  ~ 4350 km single track

  Potentially greenable: 1142 km

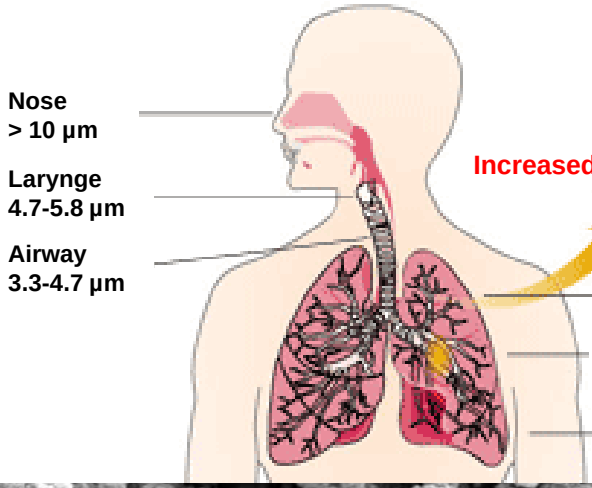
  Momentarily greened: 374 km
- 326 km grass tracks => 81.5 ha: 453 460 m³ water storage

  48 km sedum tracks => 12 ha: 47.400 m³ water storage

- Altogether: 374 km are 500 860 m³ at 790 l/m²/a precipitation on average.

Sedum track, Berlin, Germany

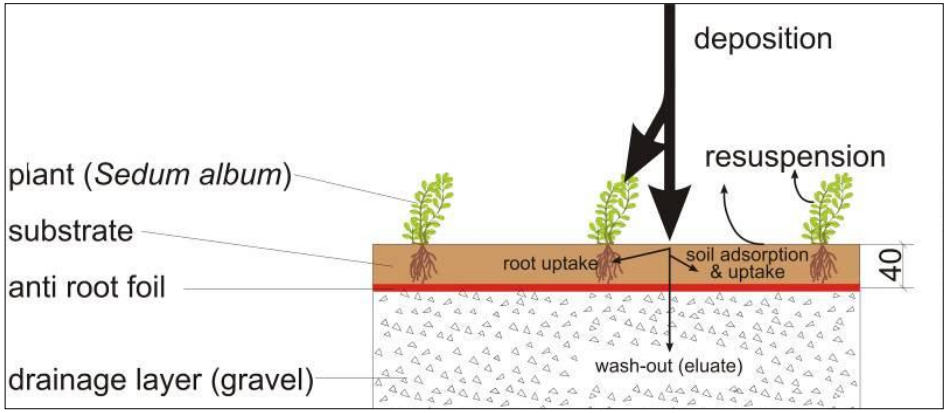
http://awearnessblog.com/NatalieBehring.jpg



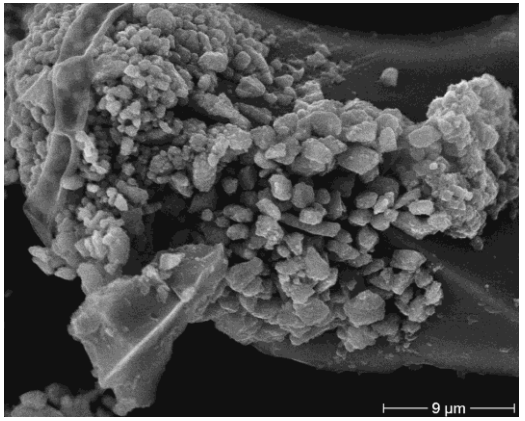
http://www.carylon.de/level9_cms/images_user/1142_Lunge_feinstaub_web.gif

30 µm

8 Fine dust – Contribution of green tracks



Path of dust through vegetation system



REM: Fe- and Si- particles on *Sedum spurium* leaf surface, 9 µm

Metals

Sedum track: Fe 5300 mg/kg dm, Mn 110 mg/kg dm, Cu 40 mg/kg dm

Reference: Fe 540 mg/kg dm, Mn 34 mg/kg dm, Cu 16.6 mg/kg dm

Polycyclic aromatic hydrocarbons (PAH)

Sedum track: 1.870 mg/kg dm

Reference: 0.989 mg/kg dm

SEM/EDX: Presence of particles below 2.5 µm
mainly Si- and Fe-particles

PSS: 99 % of the particles < 8 µm (values under reserve)
mean diameter 1,1 µm (values under reserve)

- During winter 100 % dust coverage of leaves
- Precipitation no big cleaning effect
- Accumulation of fine dust on leaf surface
- **Wind tunnel**

  Comparison: sedum vs. gravel, 0.23-20 µm

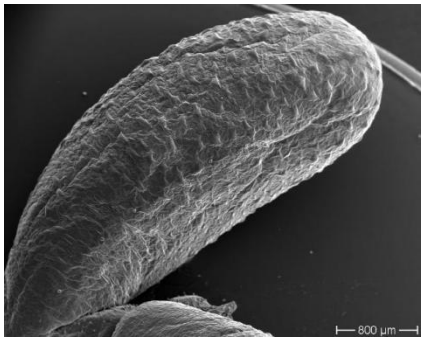
  Deposition: sedum > gravel

  1 m/s > 2 m/s

  highest deposition rate 2-10 µm

  Resuspension: sedum < gravel (2-10 µm)

Sedum album **- leaves from tram track, uncleaned**



Sedum album **- leaves, cleaned**

- **Anthropological impact on natural climate**:
  - Higher air pollution
  - Accumulation of contaminants
  - Changed water balance
  - Heat island effect
  - Loss of biodiversity
  - Higher noise level

http://www.kgs-gotha.de/jahr08/projektarbeit1/smog_mexico-city.jpg

http://www.noise-busters.com/_borders/Original_NoiseBuster98.jpg

- Huge areas covered by tram tracks
- Optical aspect
- Fine dust binding
- Improves water balance & urban microclimate
- Reduces noise
- No compensatory measures
- Biotop for flora and fauna

Ecological potential with flower power

S. sexangulare

S. album

S. spurium

S. floriferum