



# GREEN ROADS

## THE PAST - THE PRESENT - THE FUTURE

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# GREEN Roads

- **Durable**
- **Sustainable**
- **Recyclable**
- **Economic**



# GREEN Roads

**Durability** is the ability of a physical product to remain functional, without requiring excessive maintenance or repair, when faced with the challenges of normal operation over its design lifetime.

There are several measures of durability in use, including years of life, hours of use, and number of operational cycles.

In economics, goods with a long usable life are referred to as durable goods.


# GREEN Roads

**Sustainability** is the process of maintaining change in a balanced environment, in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.

For many in the field, sustainability is defined through the following interconnected domains or pillars: environment, economic and social.

Sub-domains of sustainable development have been considered also: cultural, technological and political.





# GREEN ROADS

## THE PAST

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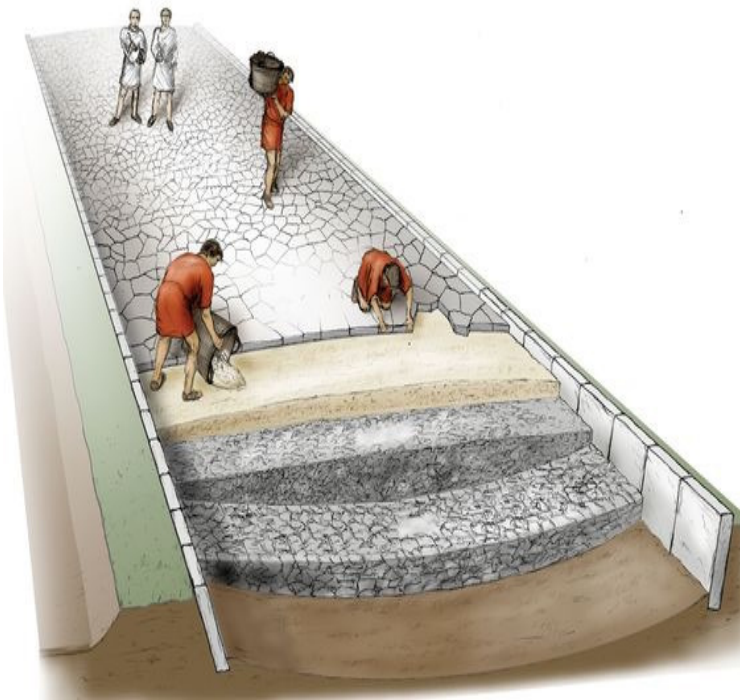


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# GREEN Roads – The Past

2000 BC







# GREEN ROADS

## THE PRESENT

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# GREEN Roads – The Present

## The road users expect

- Skid resistance
- Perfect evenness
- No water spray
- No potholes
- Noise reduction



# GREEN Roads – The Present

**The road authorities and owners expect**

- Long service-life without road works
- Sustainable use of natural resources



# GREEN Roads – The Present

## The public expects

- Noise reduction
- No road works in the neighborhood





# GREEN Roads – The Present

## Challenges

- Increasing traffic volume
- Higher axle loads
- Noise reduction
- Need for economical technologies
- Usage of recyclable materials
- Safety aspects
- Durability
- Drivers' comfort



# GREEN Roads – The Present



# GREEN Roads – The Present

## The SMA Concept

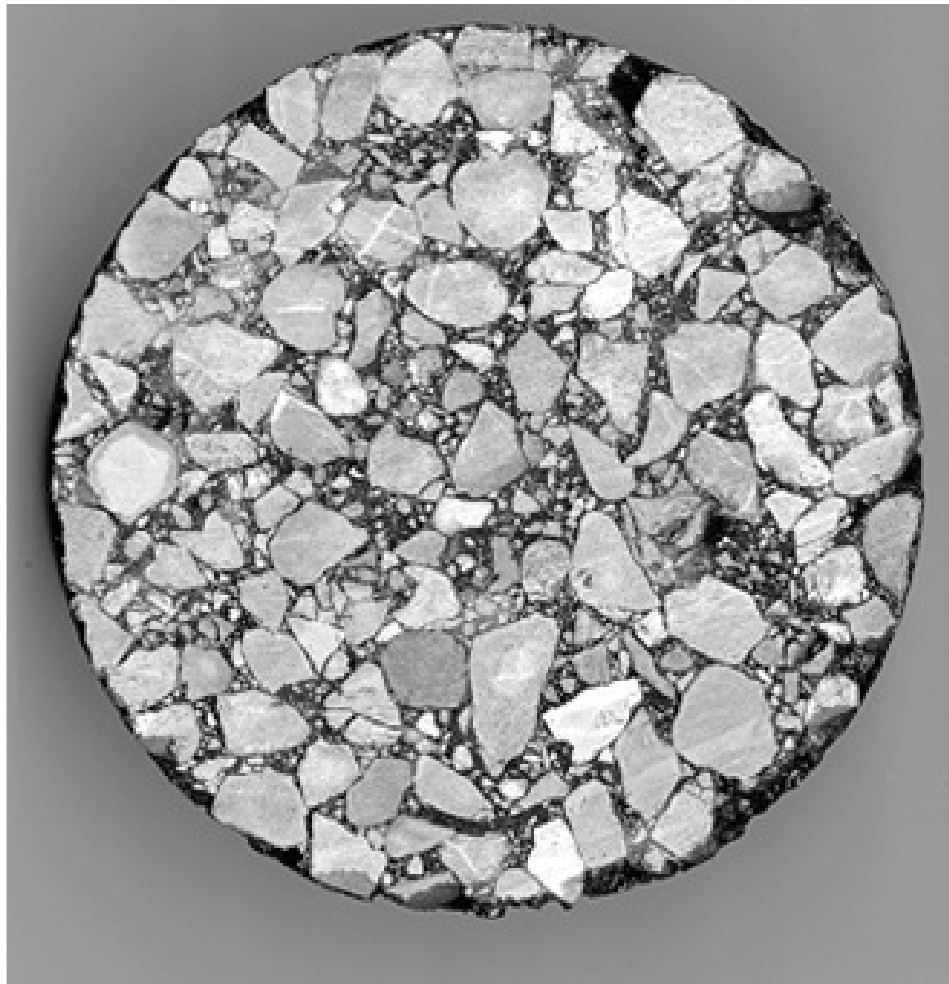
- A high amount of chippings
- A discontinuous gradation with a high content of chippings of the biggest fraction
- A high amount of binder
- A special additive to avoid binder drainage (mostly cellulose fibers)
- A higher amount of added filler
- A mix design with low air voids to make the mix practically impermeable



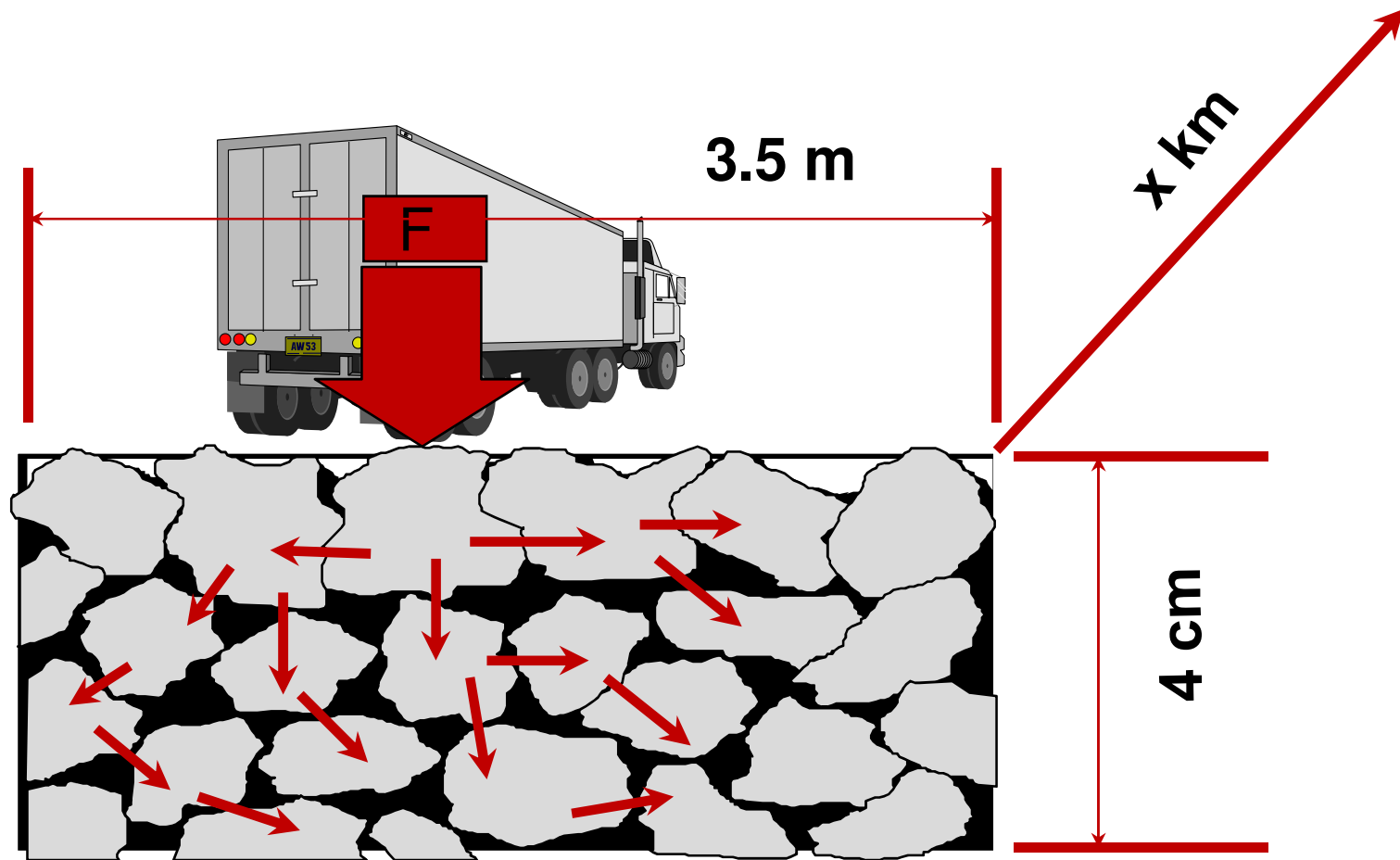


# GREEN Roads – The Present

## SMA



# GREEN Roads – The Present



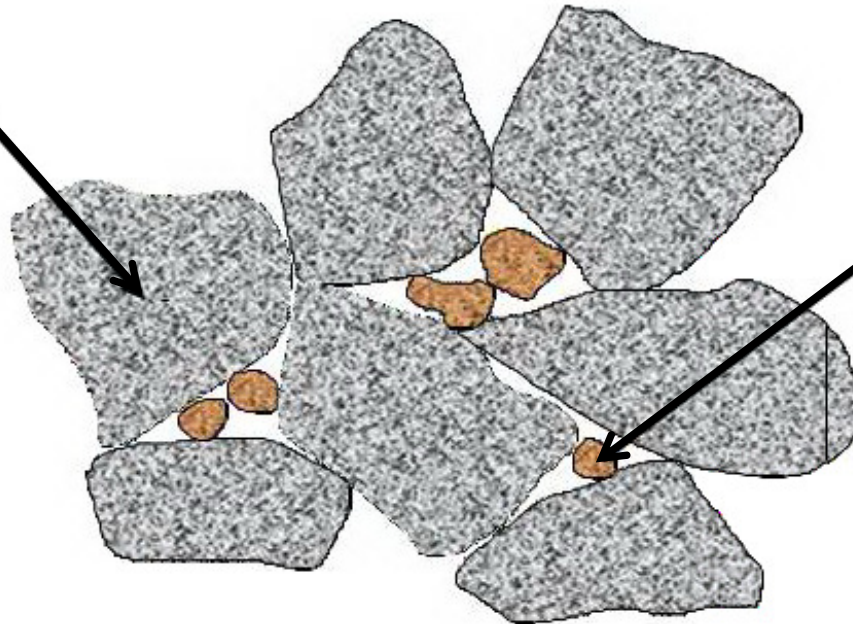
The stability in a SMA-mix is obtained through the internal friction in the self-supporting stone skeleton

# GREEN Roads – The Present

## Good Coarse Aggregate Skeleton

Coarse Aggregate

Fine Aggregate

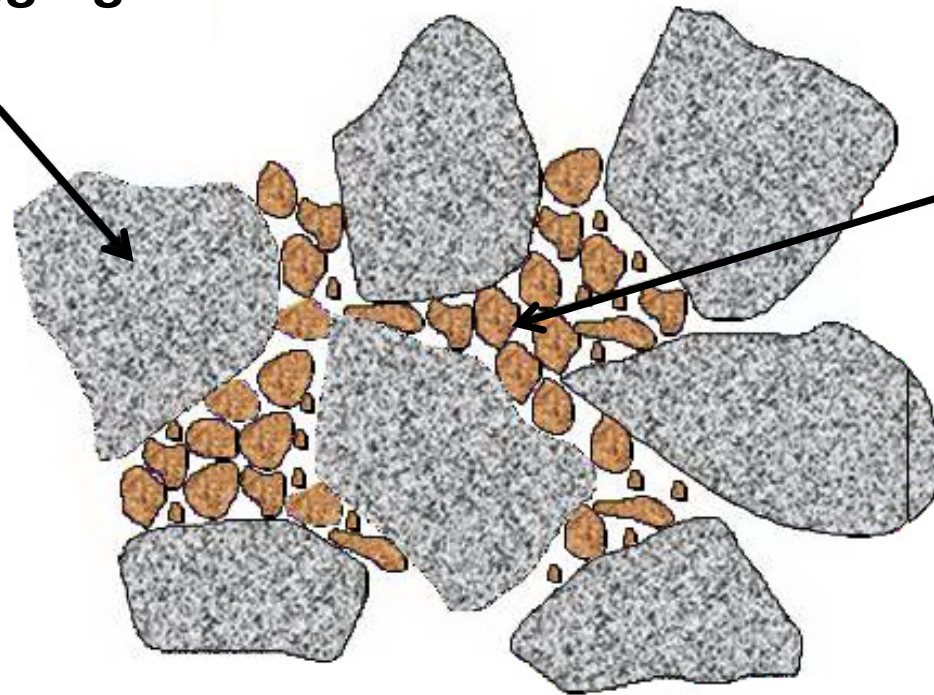




# GREEN Roads – The Present

## **Bad** Coarse Aggregate Skeleton

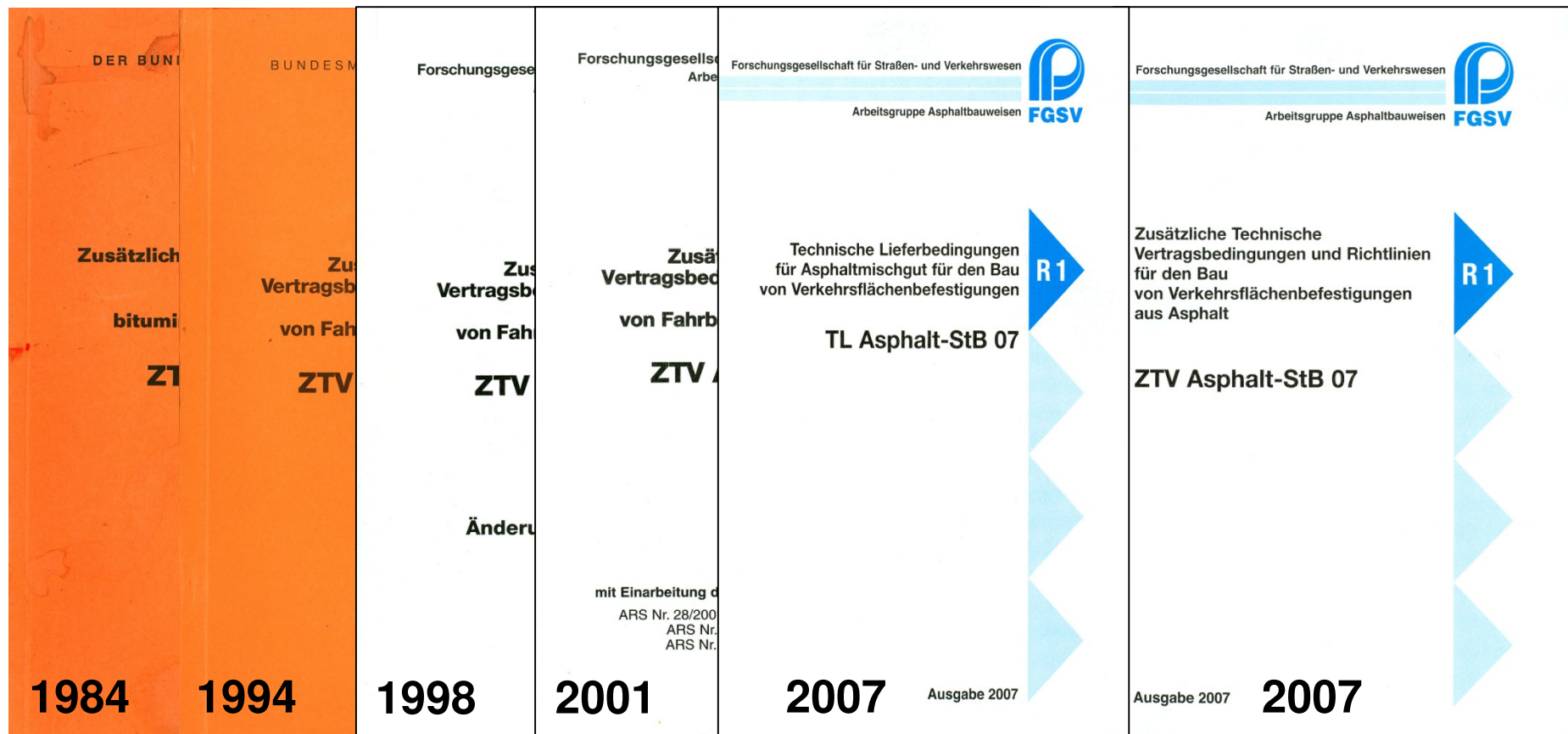
Coarse Aggregate



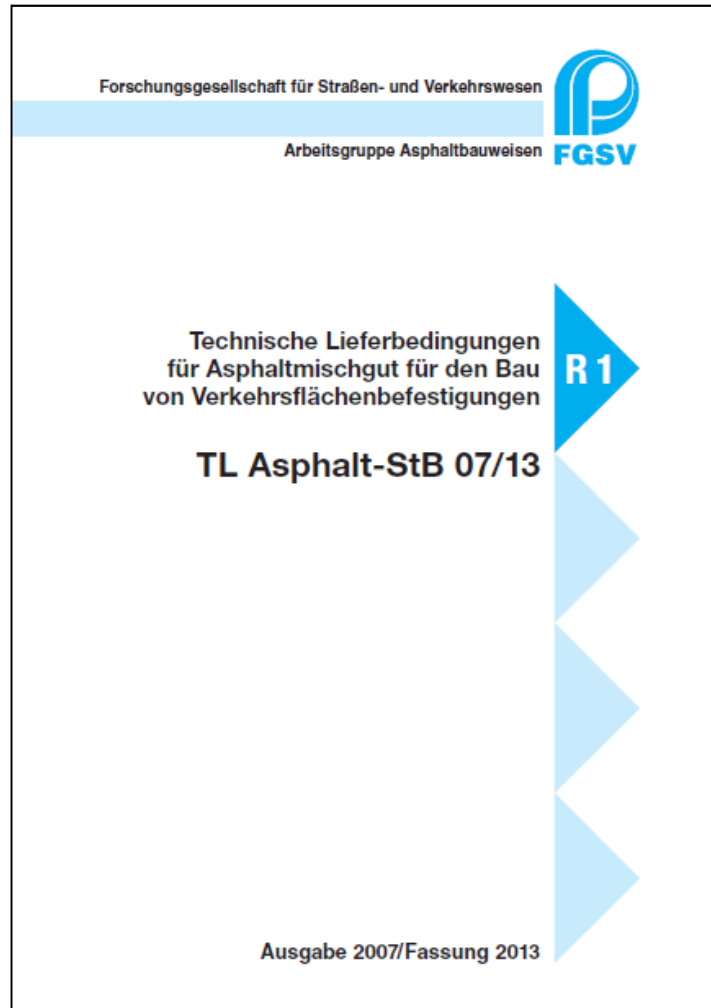
Fine Aggregate

# GREEN Roads – The Present

## Specifications in Germany



# GREEN Roads – The Present



## TL Asphalt-StB 07/13

German Technical Conditions of Delivery for Asphalt Mixtures for the Construction of Road Pavements, updated according to „ARS 11/2012“ published by the Federal Ministry of Transport, Building and Urban Development

# GREEN Roads – The Present



## ZTV Asphalt-StB 07/13

German Additional Technical Conditions of Contract and Directives for the Construction of Road Asphalt Pavements, updated according to „ARS 11/2012“ published by the Federal Ministry of transport, Building and Urban Development



# GREEN Roads – The Present

## Specifications in Germany

SMA		SMA 11 S	SMA 8 S	SMA 5 S <sup>1</sup>
Materials				
Aggregates (production size)				
Ratio crushed aggregate surface		$C_{100/0}; C_{95/1}; C_{90/1}$	$C_{100/0}; C_{95/1}; C_{90/1}$	$C_{100/0}; C_{95/1}; C_{90/1}$
Resistance to crushing		$Sz_{18} / LA_{20}$	$Sz_{18} / LA_{20}$	$Sz_{18} / LA_{20}$
Resistance to polishing		PSV <sub>specified</sub> (51)	PSV <sub>specified</sub> (51)	PSV <sub>specified</sub> (48)
Minimum part of fine aggregates with 0/2 E <sub>CS</sub> 35	%	100	100	100
Shape Index (SI)		20		
Flakiness Index (FI)		20		
Aggregate product size		$G_F 85; G_C 90/10; G_C 90/15$		
Resistance to frost		$F_1$		

<sup>1</sup> Source: Extract of ZTV BEA-StB 09, German Additional Technical Conditions of Contract and Directives for the constructional maintenance of Road Asphalt Pavements

Composition of Asphalt Mixture				
Aggregate mixture				
Passing sieve 16 mm	% by weight	100		
Passing sieve 11.2 mm	% by weight	90 – 100	100	
Passing sieve 8 mm	% by weight	50 – 65	90 – 100	100
Passing sieve 5.6 mm	% by weight	35 – 45	35 – 55	90 – 100
Passing sieve 2 mm	% by weight	20 – 30	20 – 30	30 – 40
Passing sieve 0.063 mm	% by weight	8 – 12	8 – 12	7 – 12

# GREEN Roads – The Present

## Specifications in Germany

Binder				
Binder, type and grade		25/55-55 50/70	25/55-55 50/70	45/80-50 50/70 25/55-55
Minimum binder content (factor $\alpha$ ) <sup>2</sup>		B <sub>min</sub> 6.7	B <sub>min</sub> 7.3	B <sub>min</sub> 7.4
Stabilizing additive (cellulose fibers)	% by weight	0.3	0.3	0.3

Asphalt Mixture				
Minimum void content Marshall-Specimen		V <sub>min</sub> 2.5	V <sub>min</sub> 2.5	V <sub>min</sub> 2.0
Maximum void content Marshall-Specimen		V <sub>max</sub> 3.0	V <sub>max</sub> 3.0	V <sub>max</sub> 3.0
Voids filled with bitumen	%	is to be specified	is to be specified	is to be specified
Proportional rut depth	%	is to be specified	is to be specified	—

<sup>2</sup> Factor  $\alpha$  considers the density of the aggregate mixture

Source: Extract of TL Asphalt-StB 07/13, German Technical Conditions of Delivery for Asphalt Mixtures for the Construction of Road Pavements, updated according to "ARS 11/2012" published by the Federal Ministry of Transport, Building and Urban Development

Characteristics of Layer				
Paving thickness	cm	3.5 - 4.0	3.5 - 4.0	1.5 - 2.0
Paving amount	kg/m <sup>2</sup>	85 - 100	85 - 100	30 - 50
Degree of compaction	%	≥ 98.0		≥ 96.0
Void content	Vol.-%	≤ 5.0		≤ 6.0
Gritting material		0.5 – 1.0 kg/m <sup>2</sup> aggregates 1/3 mm (dedusted or lightly bitumenized)		

Source: Extract of ZTV Asphalt-StB 07/13, German Additional Technical Conditions of Contract and Directives for the Construction of Road Asphalt Pavements, updated according to "ARS 11/2012" published by the Federal Ministry of Transport, Building and Urban Development

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## Additives

**„An improvement of the durability  
can be achieved by increasing the bitumen  
content of the asphalt mixture.**

**»Thicker binder films«**

**The more bitumen . . .  
. . . the longer the time to oxidation.“**

Hirsch, Dr. V., Ripke, Dipl.-Ing. O. – German Federal Highway Research Institute, 2008

# GREEN Roads – The Present

## Additives

**However, the maximum binder content in the aggregate structure has to be chosen very carefully, so that no deformations or fat spots at the pavement surface can occur.**

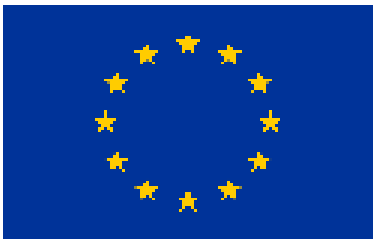
Hirsch, Dr. V., Ripke, Dipl.-Ing. O. – German Federal Highway Research Institute, 2008



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**Stabilizing additive**



**Drainage Inhibitor**



**Durability Enhancer**

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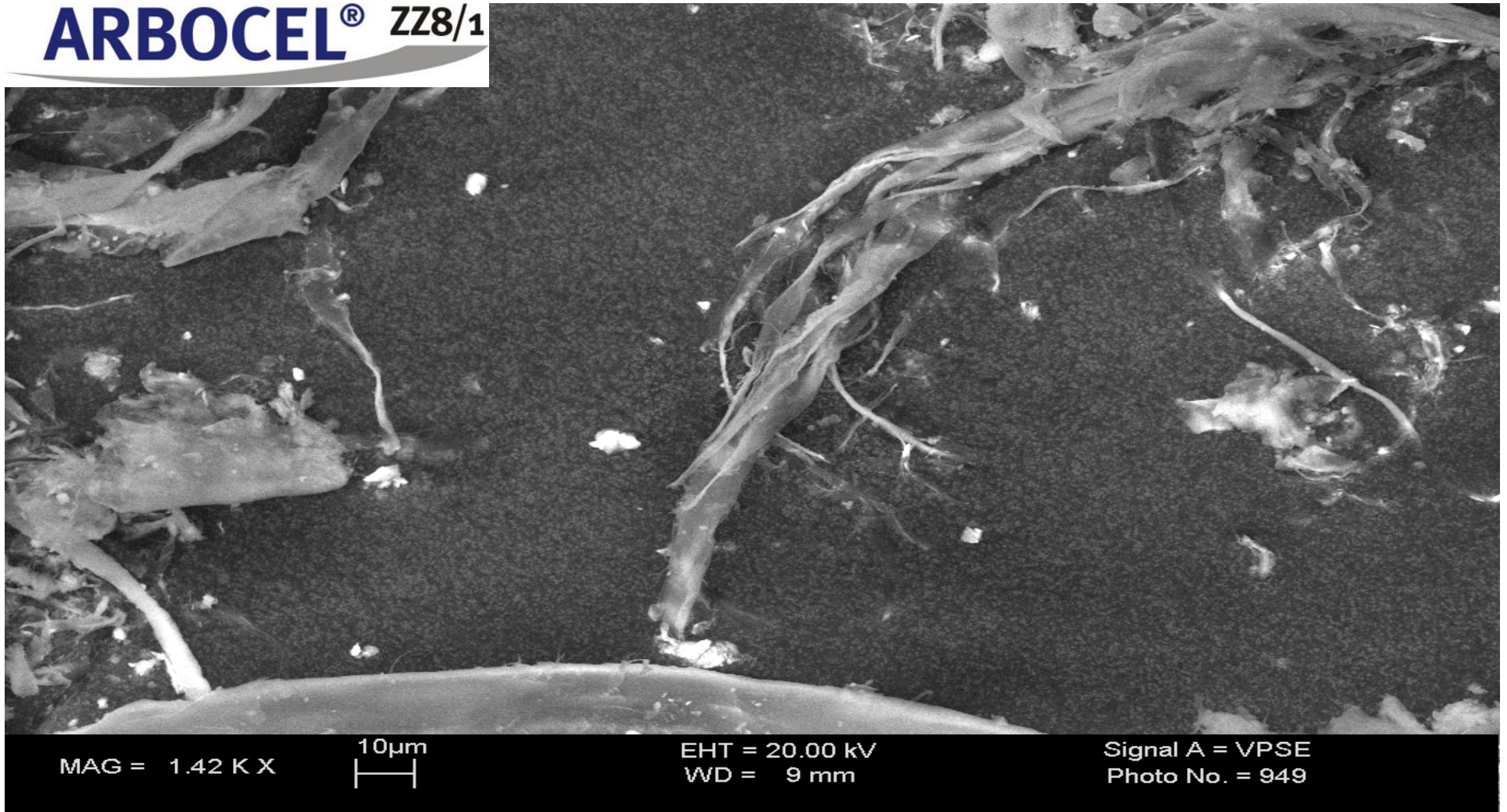
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# GREEN Roads – The Present

**ARBOCEL®** ZZ8/1



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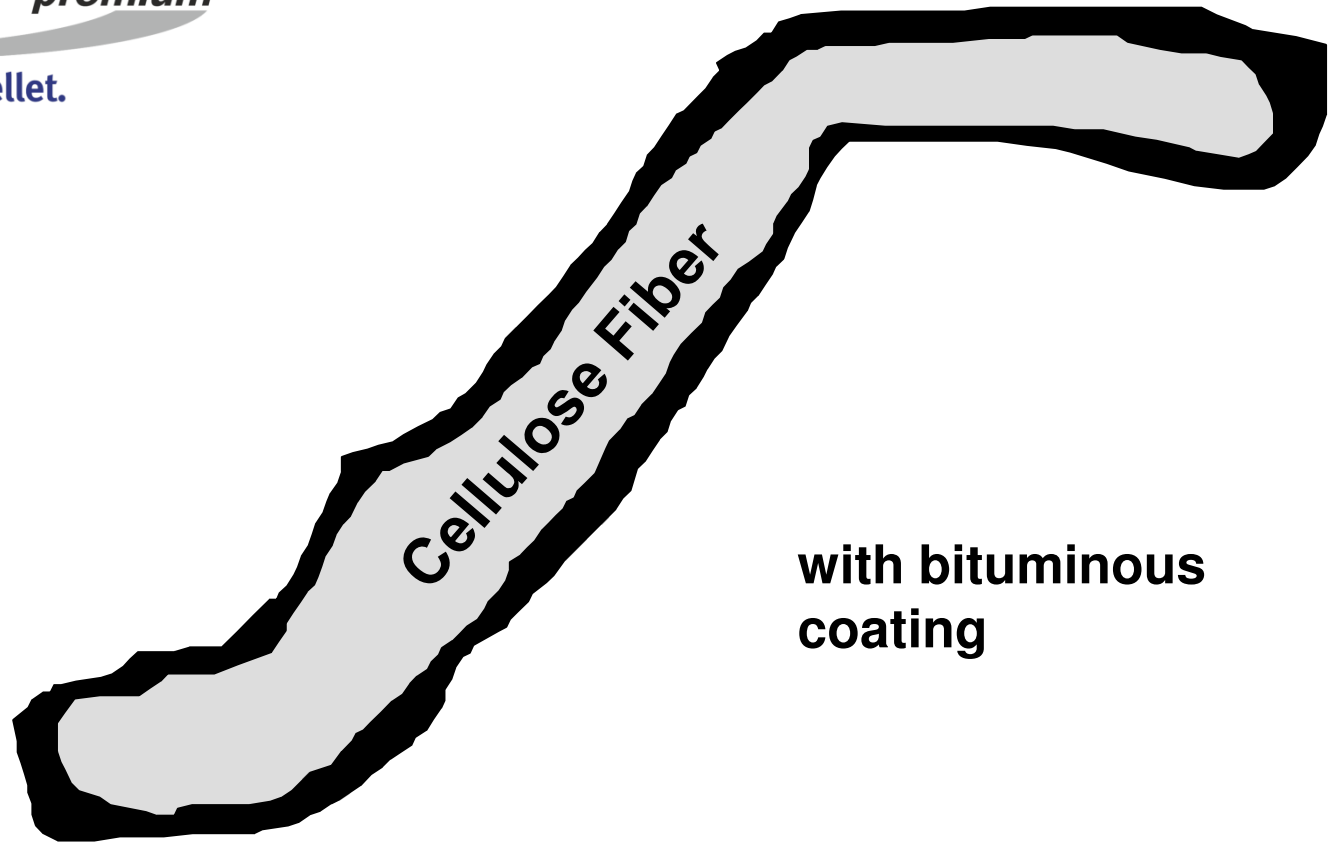


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**VIATOP® premium**

Das Pellet.



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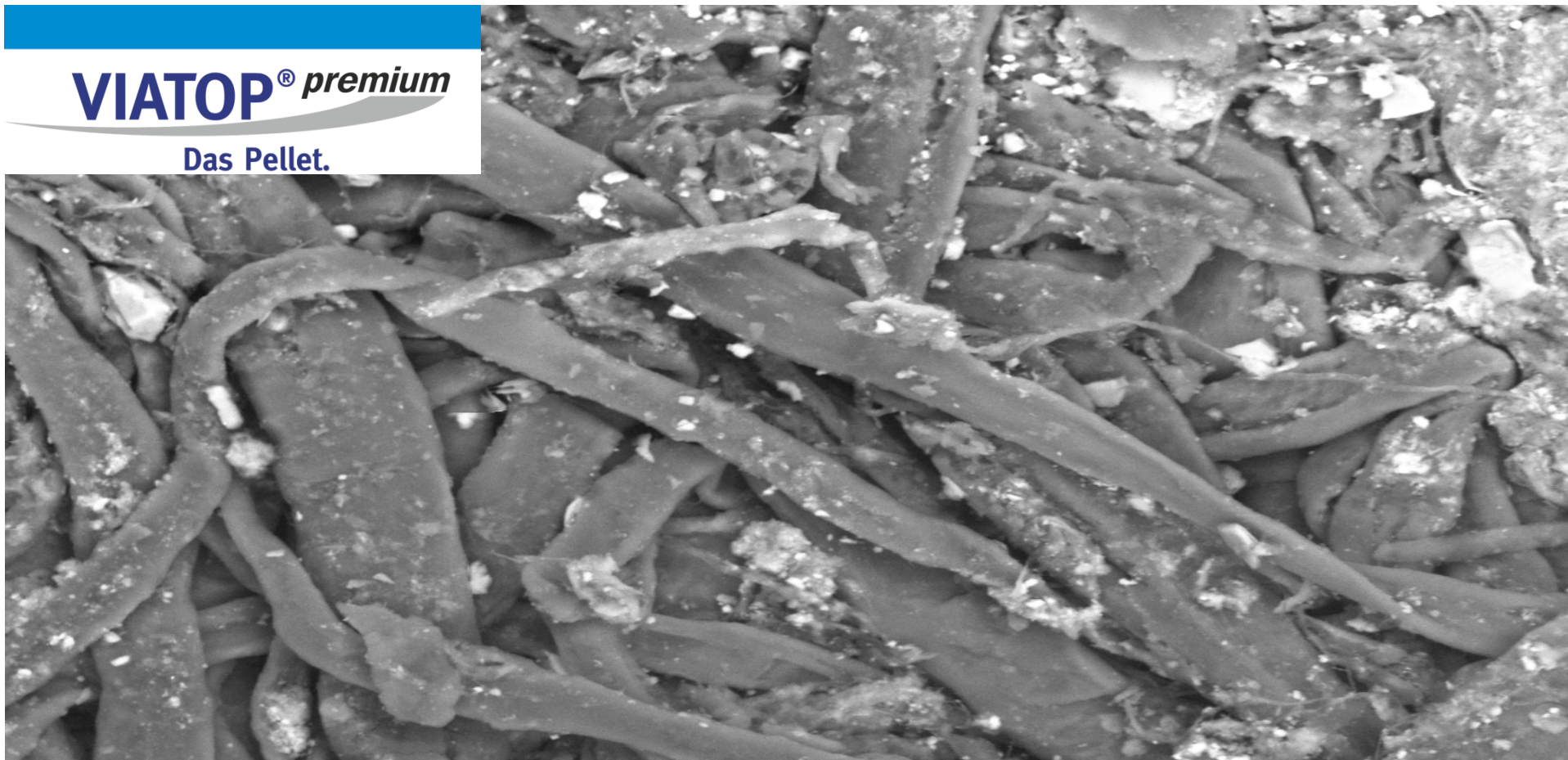


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# GREEN Roads – The Present

**VIATOP® premium**

Das Pellet.



MAG = 1.31 K X

10µm  
|—|

EHT = 20.00 kV  
WD = 10 mm

Signal A = RBSD  
Photo No. = 965

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# GREEN Roads – The Present

## SMA with VIATOP®



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# GREEN Roads – The Present

## SMA without VIATOP®



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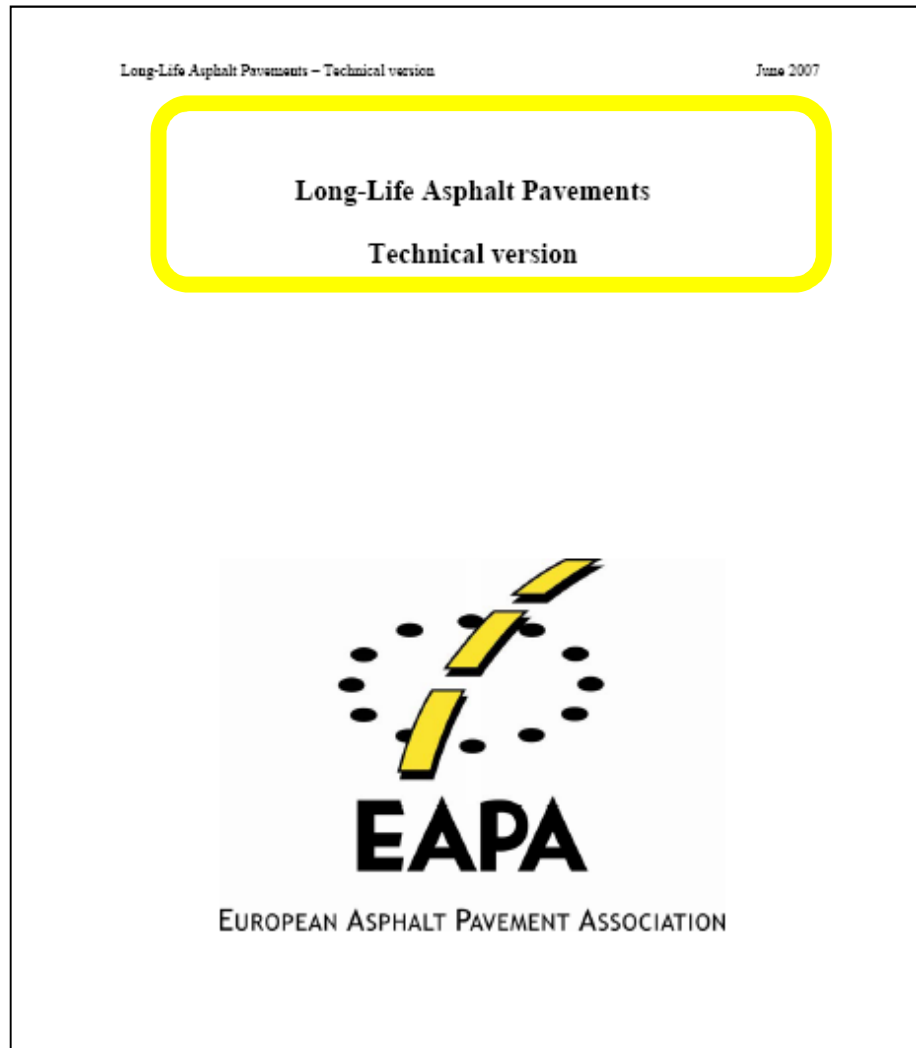
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## Lifetime of SMA

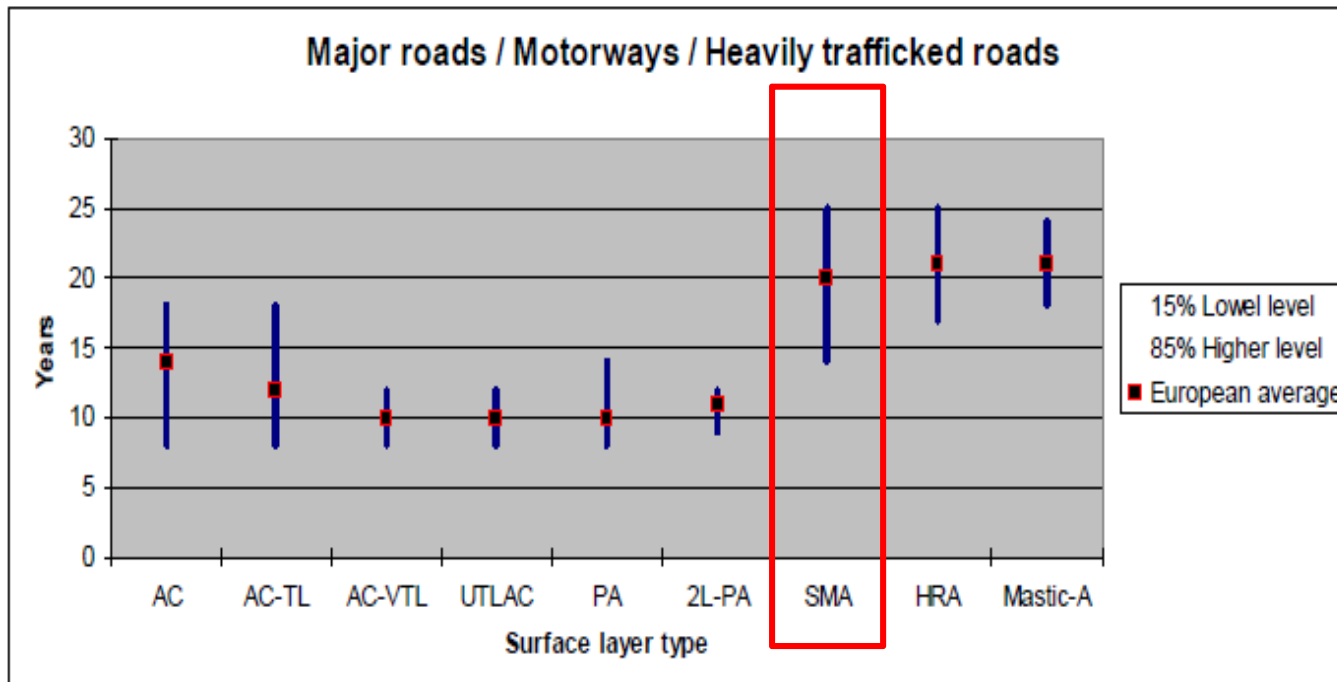


Source: Extract of EAPA's  
Long-Life Asphalt Pavements



# GREEN Roads – The Present

## Lifetime of SMA



Source: Extract of EAPA's  
Long-Life Asphalt Pavements

# GREEN Roads – The Present

## The VIATOP® Technology

Reliable – Efficient – Economical



**VIATOP® premium**

Das Pellet.

for superior durability

**VIATOP® 66**

Das Pellet.

for superior durability

**VIATOP® plus C 25**

Das Pellet.

*plus* enhanced compaction

**VIATOP® plus CT 40**

Das Pellet.

*plus* reduced process temperatures

**VIATOP® plus CT 80-AC**

Das Pellet.

*plus* temperature reduction and compaction enhancement for AC

**VIATOP® plus AD 10**

Das Pellet.

*plus* improved adhesion

**VIATOP® plus RC**

Das Pellet.

*plus* the real rejuvenating additive

**VIATOP® plus FEP**

Das Pellet.

*plus* elastomer modification for Asphalt Concrete

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# GREEN Roads – The Present



**VIATOP®** *plus C 25*  
Das Pellet.

## Composition

75 % by weight

Cellulose fibers **ARBOCEL® ZZ 8-1**

25 % by weight

Fischer-Tropsch-Wax

## Recommended Dosage for SMA mixes

0.4 % by weight



**VIATOP®** *plus CT 40*  
Das Pellet.

## Composition

60 % by weight

Cellulose fibers **ARBOCEL® ZZ 8-1**

40 % by weight

Fischer-Tropsch-Wax

## Recommended Dosage for SMA mixes

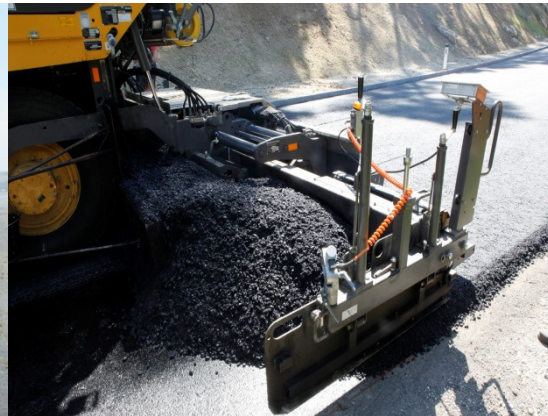
0.5 % by weight

# GREEN Roads – The Present

**VIATOP®** plus C 25  
Das Pellet.

## Properties

- Reduction of compaction resistance
- Improved application behavior esp. in case of manual works
- Earlier opening of construction site possible
- Compatibility with all types and grades of bitumen



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# GREEN Roads – The Present

**VIATOP® plus CT 40**  
Das Pellet.

## Properties

- Significant increase of long term stability – no more rutting
- Reduction of compaction resistance
- Reduction of bitumen fumes and CO<sub>2</sub> process emissions
- Improved application behavior esp. in case of manual works
- Earlier opening of construction site possible
- Widening the temperature performance range
- Compatibility with all types and grades of bitumen



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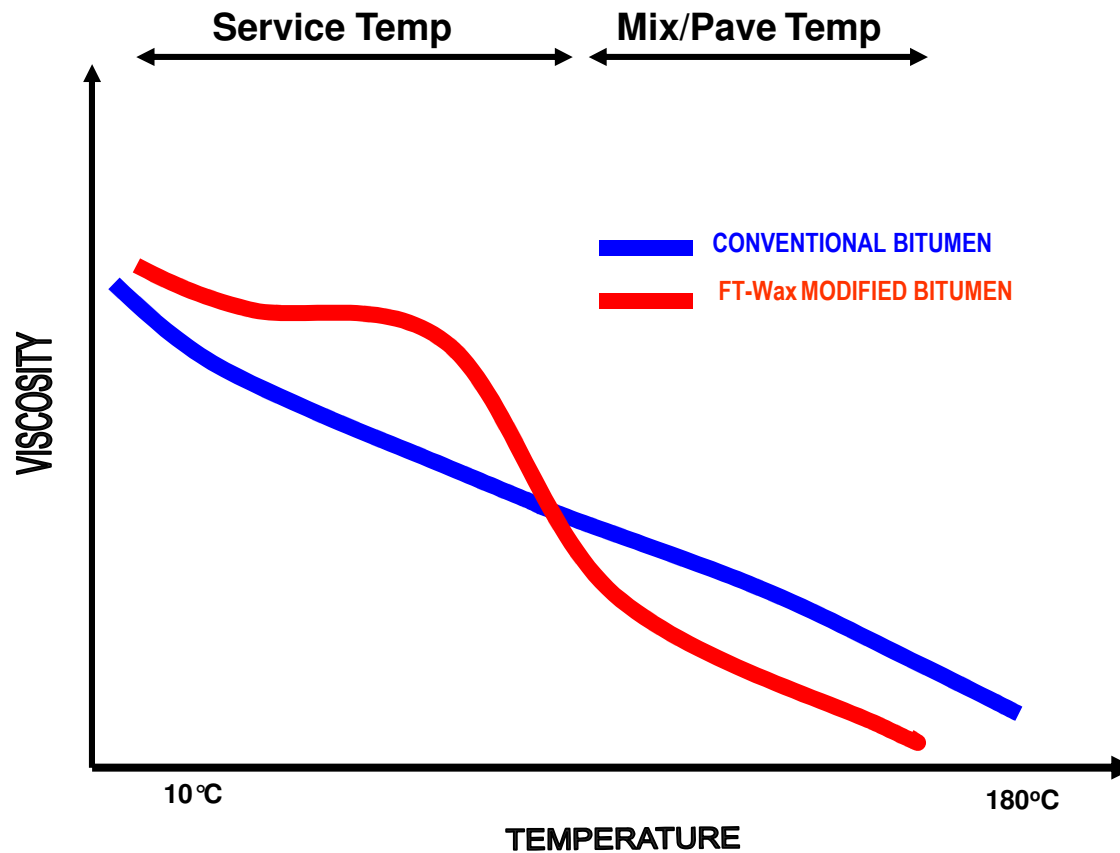
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# GREEN Roads – The Present

## Viscosity – Dynamic Shear Rheometer (DSR)





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## THE FUTURE



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# GREEN Roads – The Future

## Recycling of Asphalt Pavements (RAP)



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## Characteristics of RAP

- Change of properties due to aging
- Aging lead to binders which are:
  - stiffer,
  - less ductile and
  - more susceptible to temperature variations.
- The aging process reduces the ratio of the oily phase (maltenes) in the binder, leaving a greater ratio of stiffer asphaltenes, which lead to a less ductile binder.
- These viscosity and elasticity changes result in a hardened, brittle binder.

# GREEN Roads – The Future

- Restoring the properties of aged binder
- Improving mix flexibility
- Reducing consumption of virgin materials



Keyword:

**R E J U V E N A T I O N**

# GREEN Roads – The Future

## Rejuvenation

Rejuvenation means

**reducing the overall viscosity**

and at the same time

**restoring the viscoelastic properties**

of an aged binder.

# GREEN Roads – The Future

Developing a new  
kind of a **REAL**  
rejuvenator





# GREEN Roads – The Future

## Function of a **REAL** Rejuvenator

- Restore the physical and rheological characteristics of an aged binder to the requirements of current binder specifications
- Activate aged binder and not just soften or plasticize the binder
- Eliminate/reduce cracking & maintain/improve rut-resistance
- Improve relaxation, ductility, cohesive and adhesive properties of the aged binder

# GREEN Roads – The Future



**VIATOP®** *plus RC*  
Das Pellet.

## Composition

50 % by weight

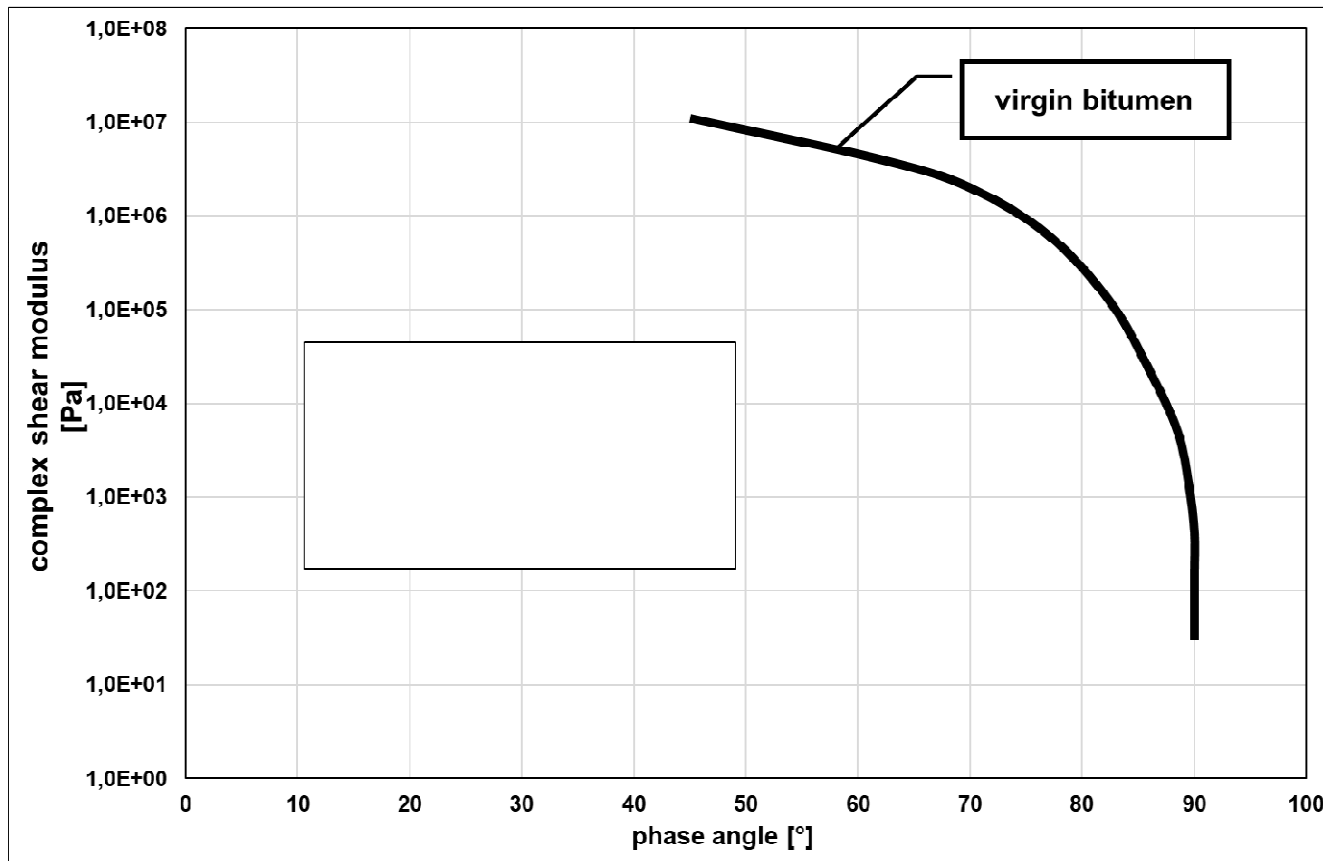
Cellulose fibers **ARBOCEL® ZZ 8-1**

50 % by weight

Rejuvenator

# GREEN Roads – The Future

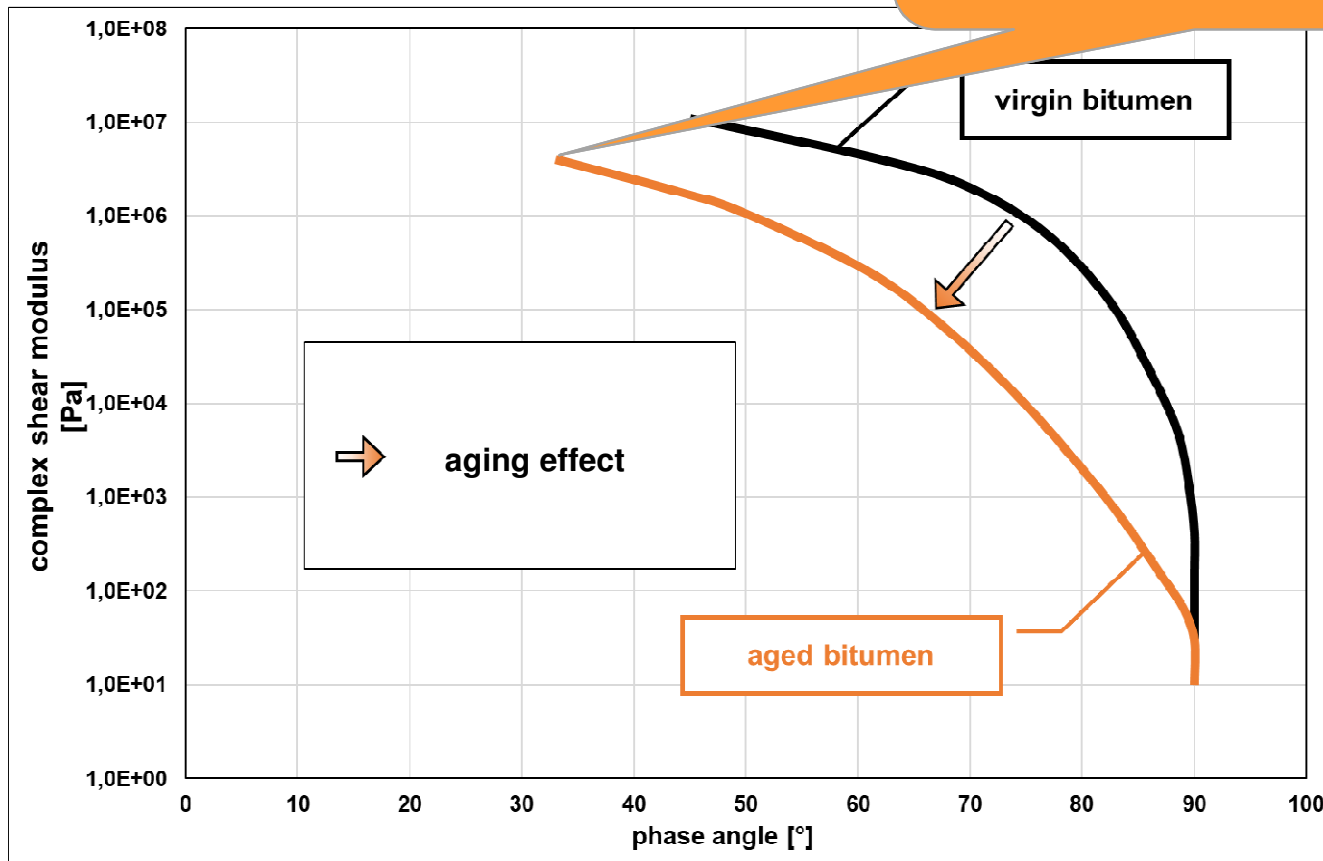
REAL rejuvenator or just plasticizer?



# GREEN Roads – The Future

REAL rejuvenator or just plasticizer?

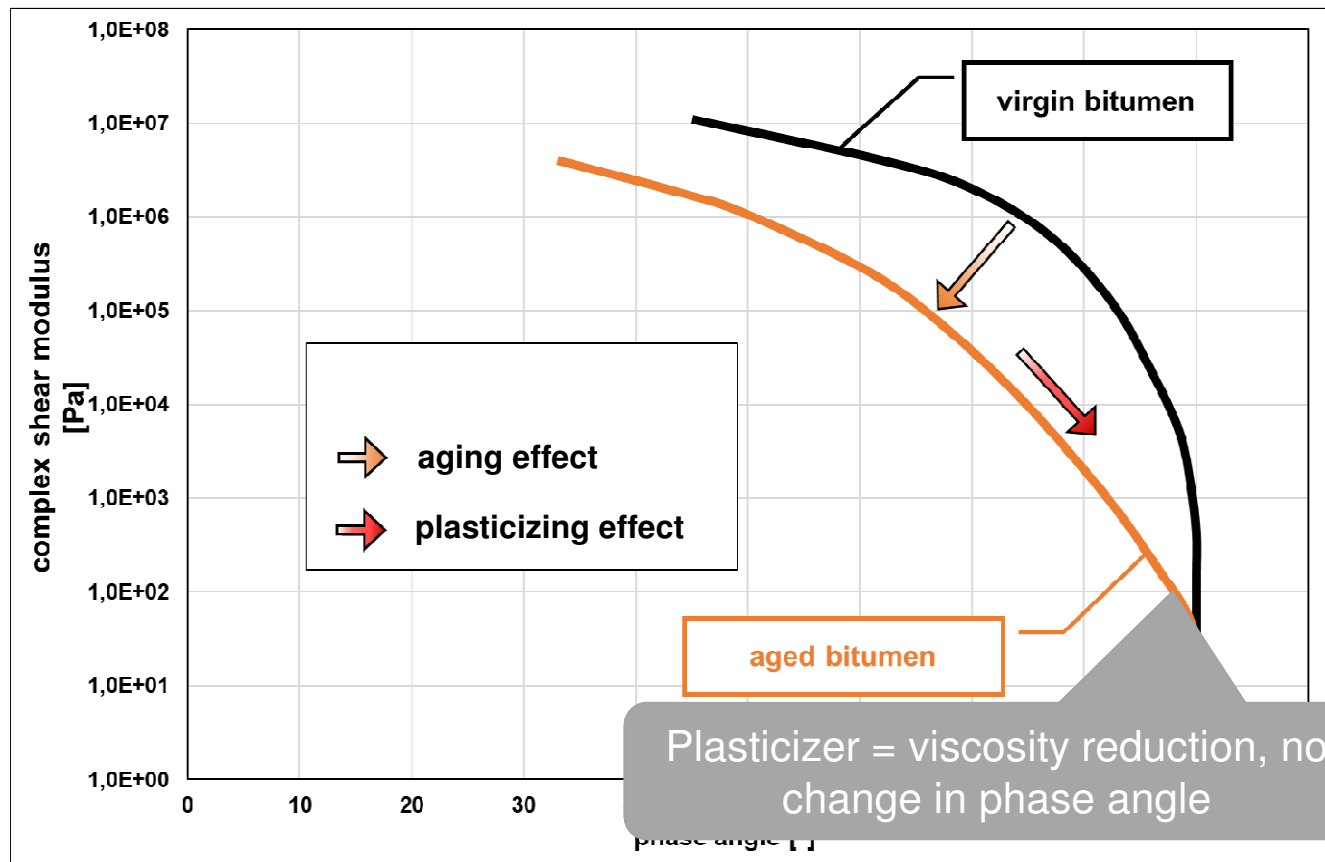
Aged bitumen = increased viscosity and decreased phase angle





# GREEN Roads – The Future

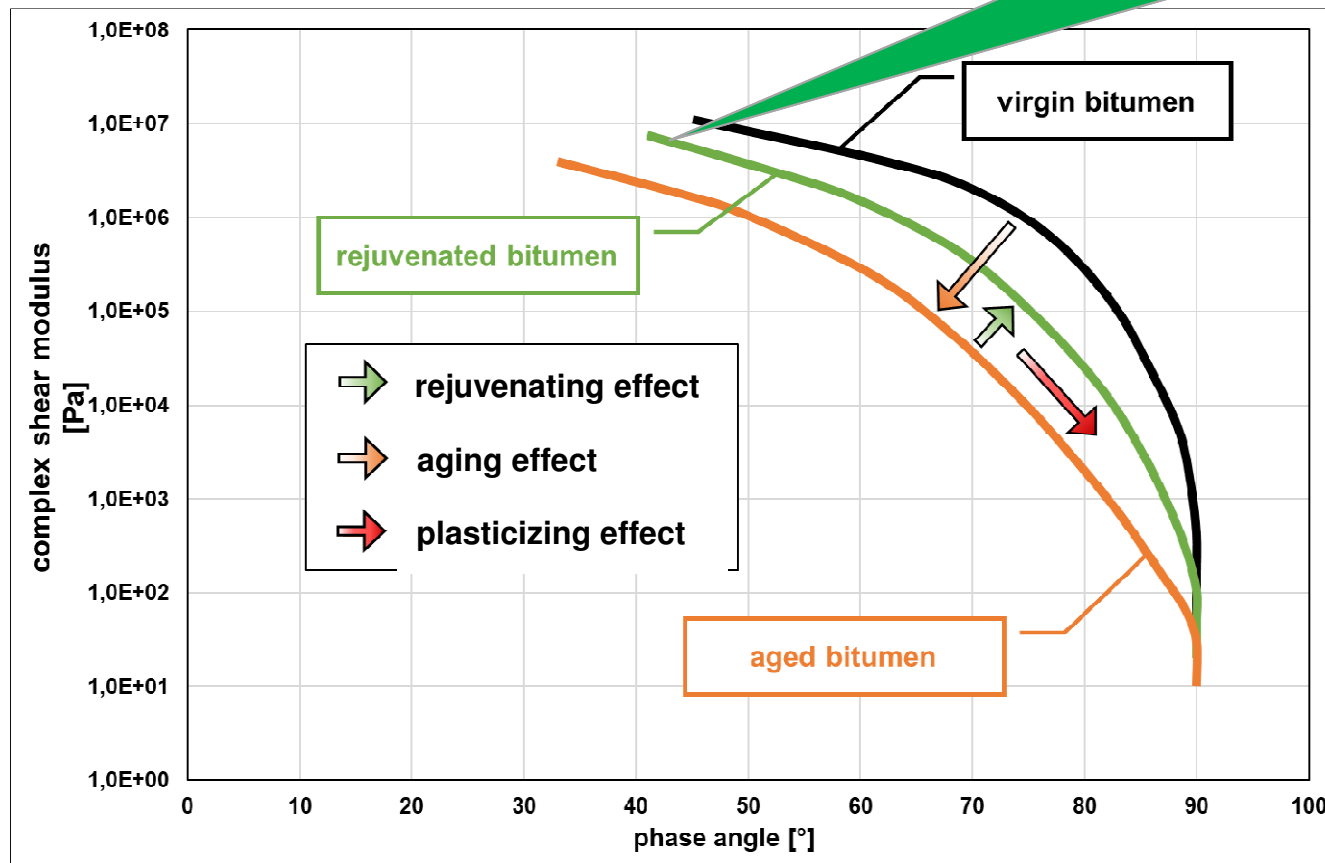
REAL rejuvenator or just plasticizer?



# GREEN Roads – The Future

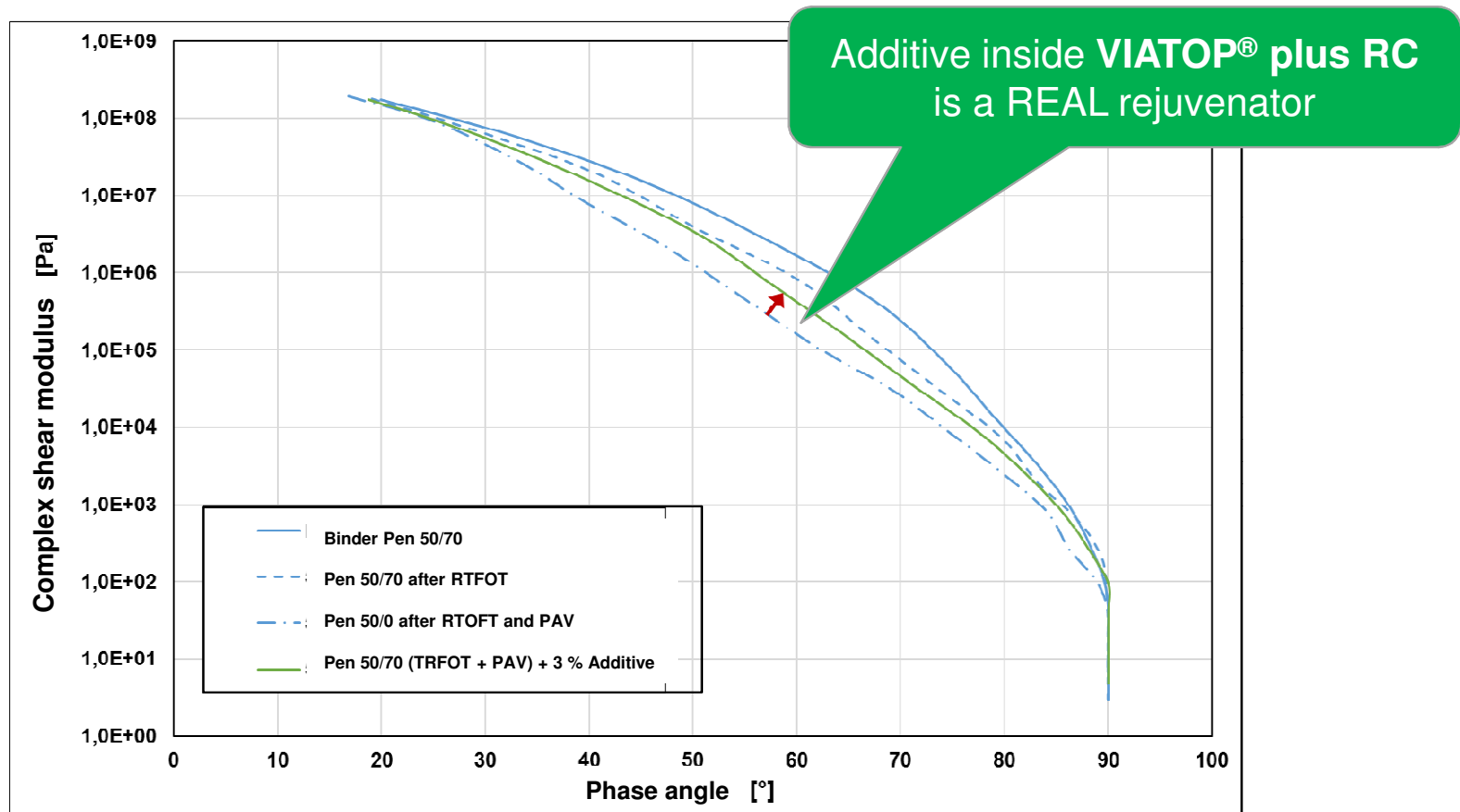
REAL rejuvenator or just plasticizer?

REAL rejuvenator reversed the aging



# GREEN Roads – The Future

REAL rejuvenator or just plasticizer?



# GREEN Roads

## Durable

The ability of a physical product to remain functional, without requiring excessive maintenance or repair, when faced with the challenges of normal operation over its design lifetime.



# GREEN Roads

## Sustainable

The process of maintaining change in a balanced environment, in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.

# GREEN Roads

## Recyclable

Reuse of RAP-material in highest possible quantities with real rejuvenated binder





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## THE PAST - THE PRESENT - THE FUTURE

SMA – SIN MANTENIMIENTO ANTICIPADO

# Q & A

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