Hrvatsko asfaltersko društvo **Croatian asphalt association**

Utjecaj kvalitete bitumena u novom postupku projektiranja asfaltnih kolnika u Austriji

The influence of the bitumen quality in new Austrian asphalt pavement design

Markus Spiegl, OMV Refining & Marketing

Međunarodni seminar ASFALTNI KOLNICI 2016
International seminar ASPHALT PAVEMENTS 2016
Opatija, 06.–07. 04. 2016.

Content

- New Austrian asphalt pavement design
- Bitumen and asphalt mixture types
- Input data – performance related material properties
- Examples
  - Secondary road (load class 0,4)
  - Highway (load class 10)
- Resume
- Outlook

New Austrian asphalt pavement design

Hrvatsko asfaltersko društvo Croatian asphalt association

Novi pristup projektiranja asfaltnih kolnika u Austriji

New approach in Asphalt Pavement Design in Austria

Maximilian Weixlbaum, Gestrata

Međunarodni seminar ASFALTNI KOLNICI 2016
International seminar ASPHALT PAVEMENTS 2016
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New Austrian asphalt pavement design

Influencing parameters

Traffic – heavy vehicles

- Standard collective (predetermined)
- Toll collecting data from ASFiNAG or traffic counting (resp. traffic estimation)
- Vehicle weighing data

➔ **eligible depending on availability of data**

Climate

- Climate zone I or II

Performance related material properties

- Minimum stiffness S_{min} Asphalt (surface, binder and base layer)
- Fatigue resistance ε_6 (base layer)

➔ **performance declaration of asphalt producer (initial type testing)**

Pavement structure

- Minimum bearing capacity of unbound subbase layers
- Type and thickness of unbound or bound subbase layers
- class of the unbound subbase layers according to RVS 08.15.01

➔ **individual eligible**

Bituminous binder properties

OMV Paving grade bitumen 70/100

Requirement / Characteristic	**Unit**	**Range of Values**
Penetration at 25°C	x0.1 mm	70 - 100
Softening point	°C	43 -51
Mass change at 163°C	%	≤ 0.8
Retained penetration	%	≥ 46
Softening point after hardenng	°C	≥ 45
Increase in softening point	°C	≤ 9
Flash point	°C	≥ 230
Fraass breaking point	°C	≤ – 10
Solubility	% (m/m)	≥ 99
Dynamic viscosity at 60°C	Pa.s	≥ 90
Kinematic viscosity at 135°C	mm^2/s	≥ 230

Bituminous binder properties

Type of Binder acc. EN 14023		OMV Starfalt® PmB		
		25/55-65	**45/80-65**	**45/80 RC**
Requirement / Characteristic	**Unit**	**Range of Values**		
Penetration at 25°C	x0.1 mm	25 - 55	45 - 80	45 - 80
Softening point	°C	≥ 65	≥ 65	≥ 70
Force ductility	J/cm²	≥ 3 (5°C) ≥ 3 (10°C)	≥ 3 (5°C)	≥ 3 (5°C)
Mass change at 163°C	%	≤ 0,5	≤ 0,5	≤ 0,5
Retained penetration	%	≥ 60	≥ 60	≥ 60
Increase in softening point	°C	≤ 8	≤ 8	≤ 8
Flash point	°C	≥ 250	≥ 250	≥ 250
Fraass breaking point	°C	≤ – 12	≤ – 18	≤ – 18
Elastic recovery (25°C)	%	≥ 80	≥ 80	≥ 80
Storage stability - difference in softening point	°C	≤ 5	≤ 5	≤ 5
Elastic recovery (25°C) acc. to EN 12607	%	≥ 60	≥ 70	≥ 70

Asphalt mixture types

Surface layer

- AC 11 surface 70/100
- AC 11 surface PmB 45/80-65

Binder layer

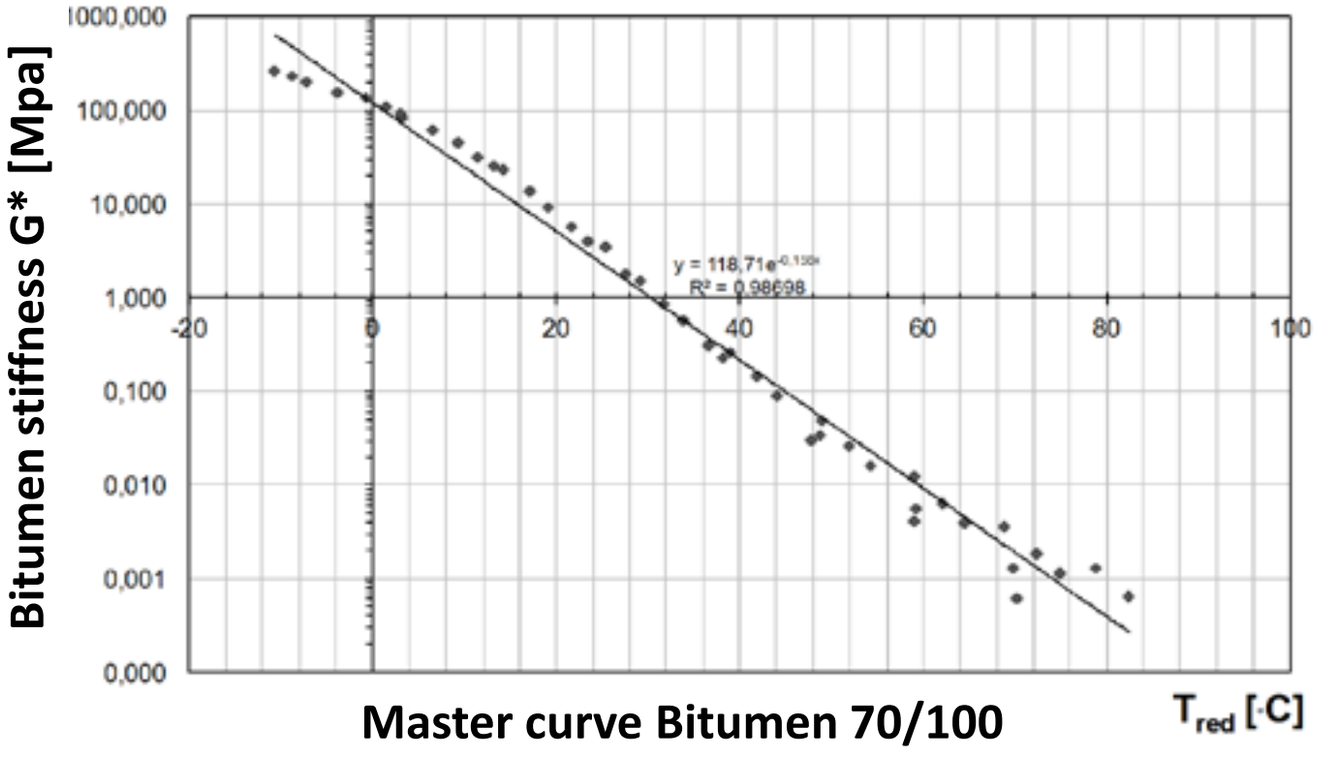
- AC 22 binder 70/100
- AC 22 binder PmB 25/55-65
- AC 22 binder PmB 45/80-65
- AC 22 binder PmB 45/80 RC with 20 % RAP

Base layer

- AC 32 base 70/100
- AC 32 base PmB 45/80-65
- AC 32 base PmB 45/80 RC with 20% RAP

New Austrian asphalt pavement design

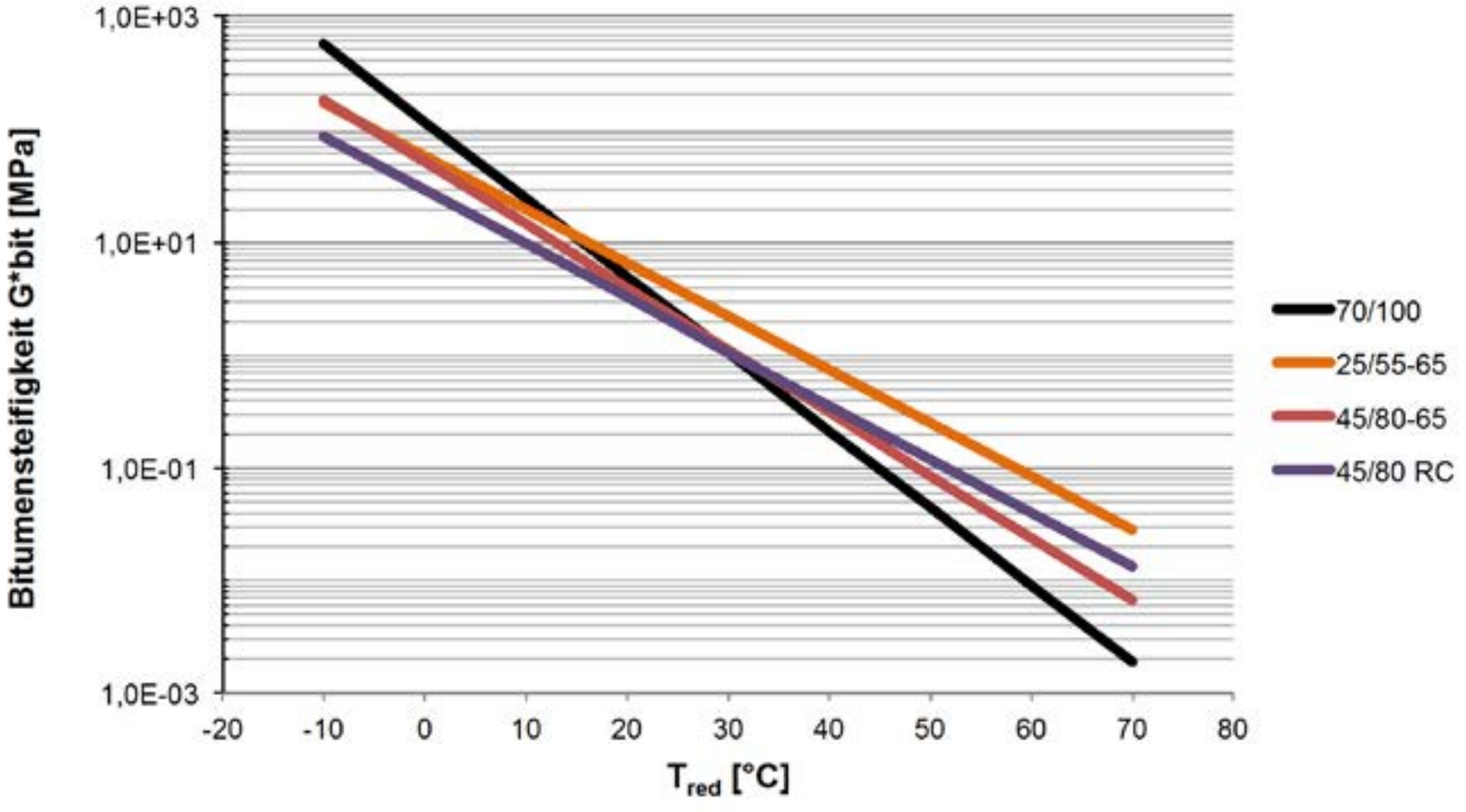
Rheological properties of the binder



- DSR test with standardized test protocol
- Master curve in a temperature range from -15 (-20) till 80°C
- Binder stiffness G* as input for the Vienna design model

New Austrian asphalt pavement design

Rheological properties (DSR) of the binder



Master curves of the selected bituminous binders to calculate the input parameters for the Vienna Modell

New Austrian asphalt pavement design

Asphalt stiffness – Vienna Model

$$S_{mix}(T) = \frac{p}{145{,}0377} \cdot \left[a \cdot \left(1 - \frac{VMA}{100} \right) + 145{,}0377 \cdot 3 \cdot |G^*_{bit}|(T) \cdot \left(\frac{VFB \cdot VMA}{10.000} \right) \right] +$$

$$+ \frac{(1 - p_c)}{145{,}0377} \cdot \left[\frac{1 - \frac{VMA}{100}}{a} + \frac{VMA}{VFB \cdot 145{,}0377 \cdot 3 \cdot |G^*_{bit}|(T)} \right]^{-1}$$

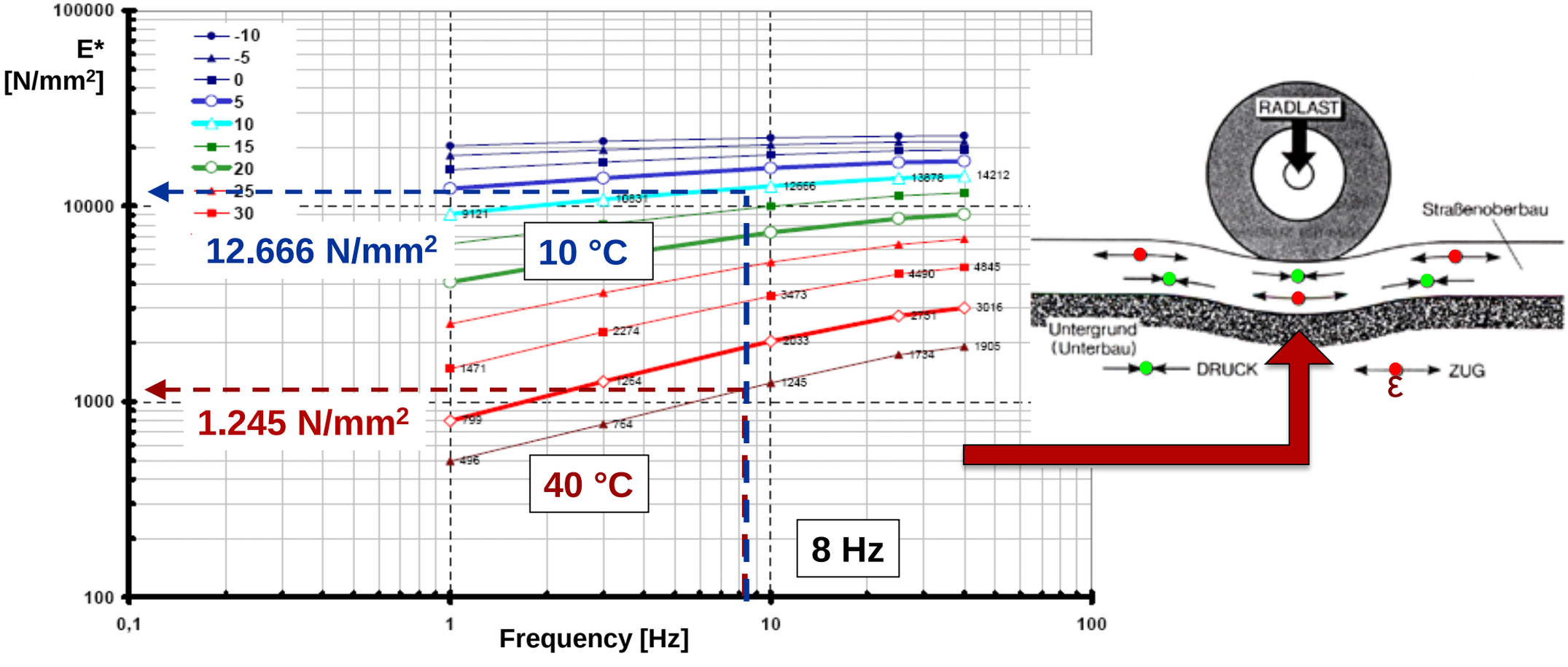
$$p = \frac{\left(b + \frac{VFB \cdot 145{,}0377 \cdot 3 \cdot |G^*_{bit}|(T)}{VMA} \right)^c}{d + \left(\frac{VFB \cdot 145{,}0377 \cdot 3 \cdot |G^*_{bit}|(T)}{VMA} \right)^c}$$

- **Volumetric property** of the asphalt
- **Bitumen stiffness G*** at the relevant Temperature & loading frequency
- **Dynamic stiffness S_{mix}** as input for the road design

New Austrian asphalt pavement design

Performance related properties of asphalt mix

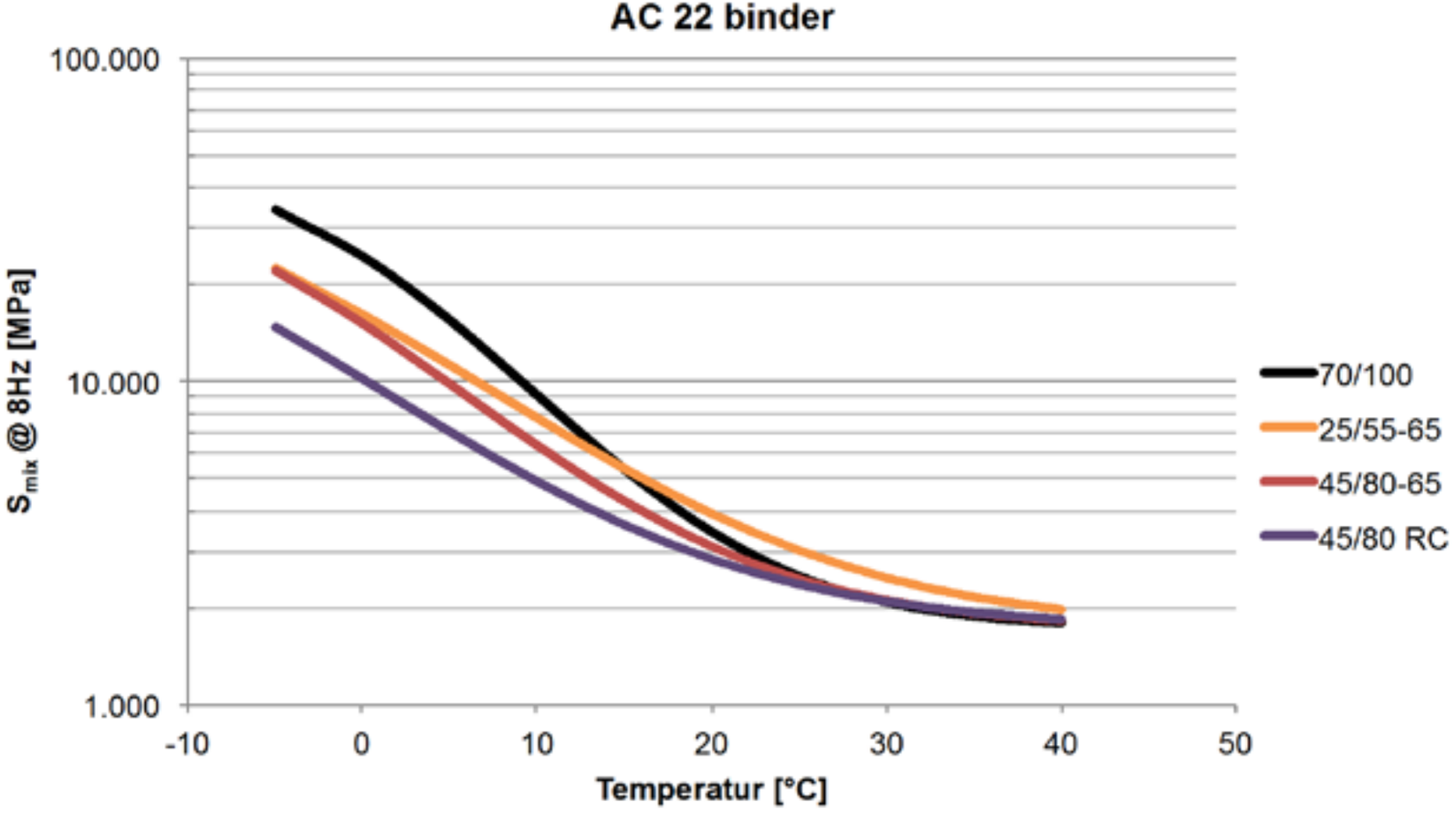
Asphalt property – stiffness (4PB acc. EN 12697-26)



New Austrian asphalt pavement design

Performance related properties of asphalt mix

Asphalt stiffness – Vienna Model

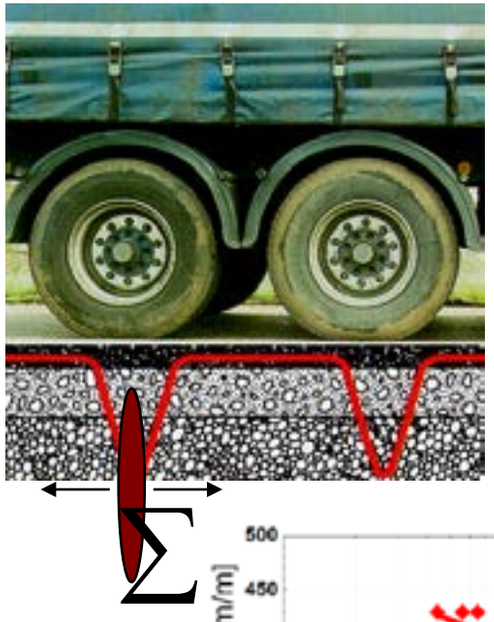


Temperature depended stiffness S_{mix} for AC 22 binder with different bituminous binders

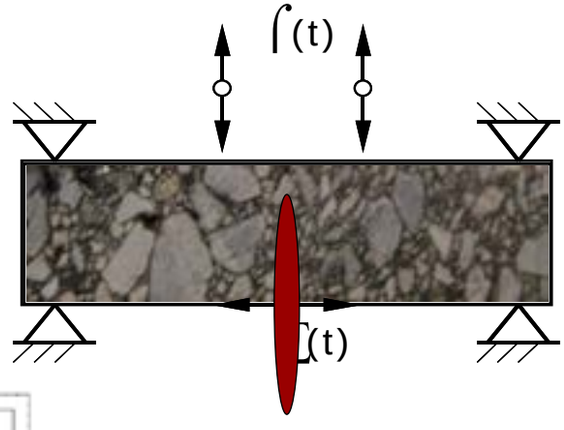
New Austrian asphalt pavement design

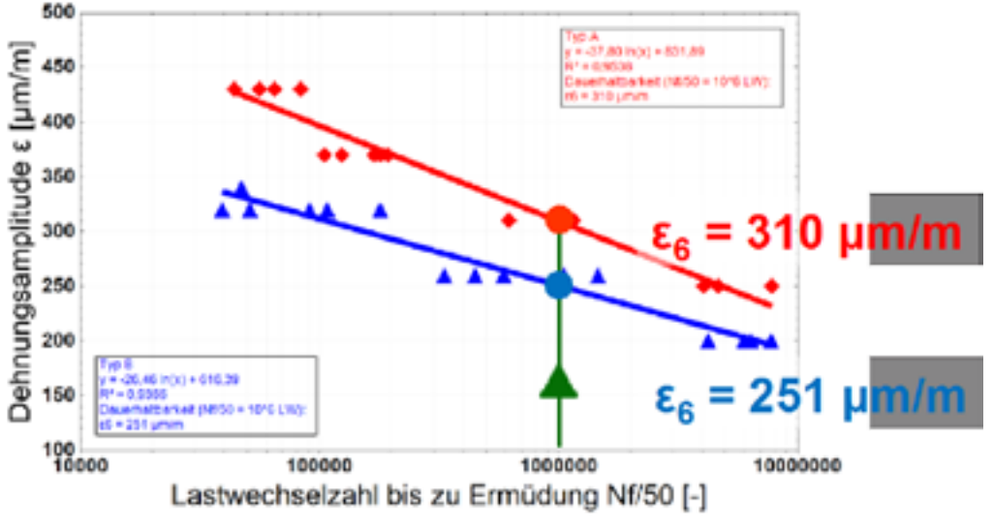
Performance related properties of asphalt mix

Asphalt property – fatigue (4PB acc. EN 12697-24)



Long term test
criteria for fatigue

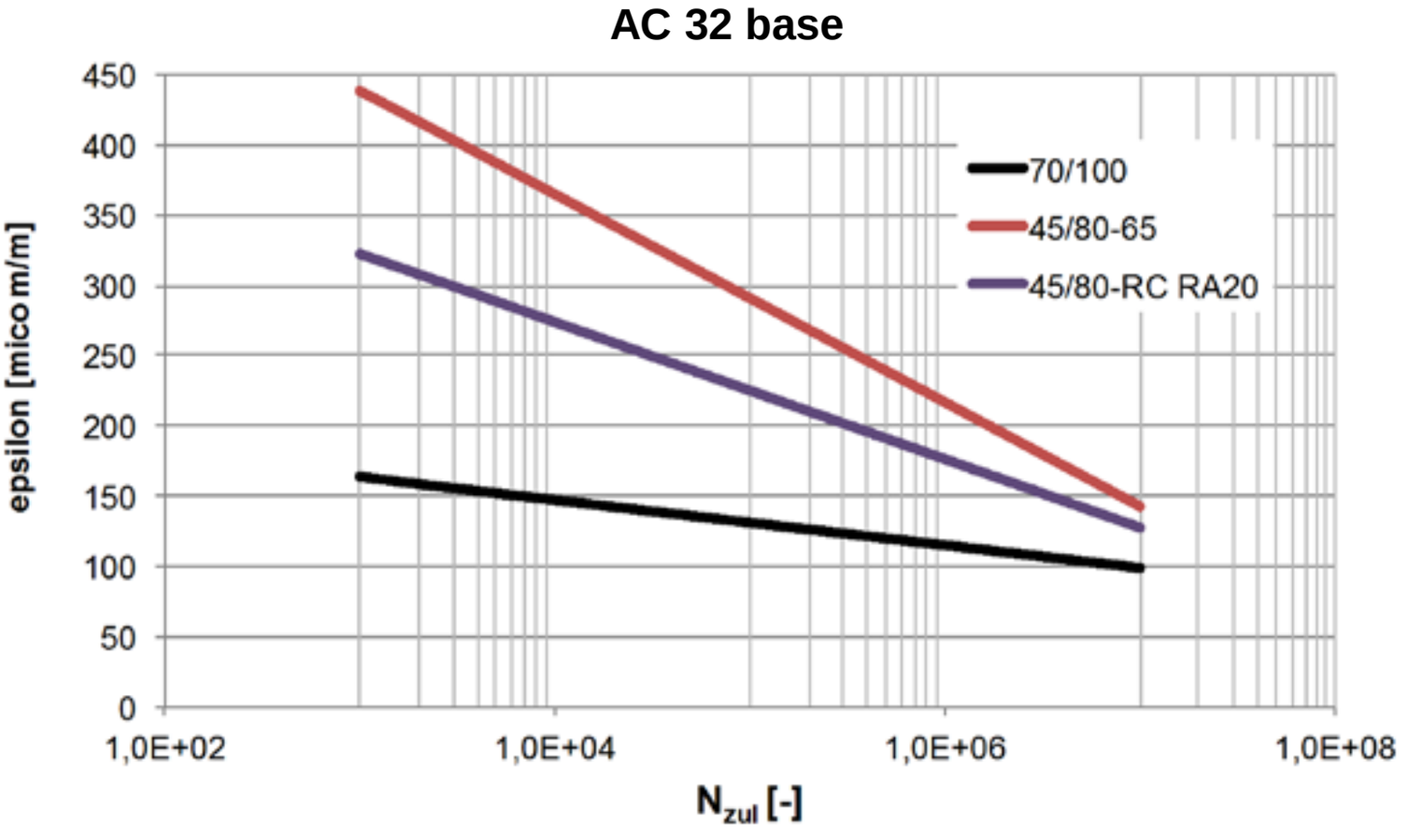




Statistical evaluation of fatigue tests for asphalt base and binder layers with various bituminous binder

New Austrian asphalt pavement design

Performance related properties of asphalt mix

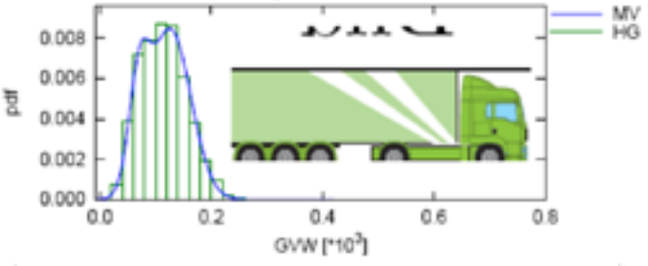


Fatigue curve based on 4 point bending beam tests for the used asphalt mixtures and bituminous binders

Numeric Model

Determination of the primary effect

Total weight distribution

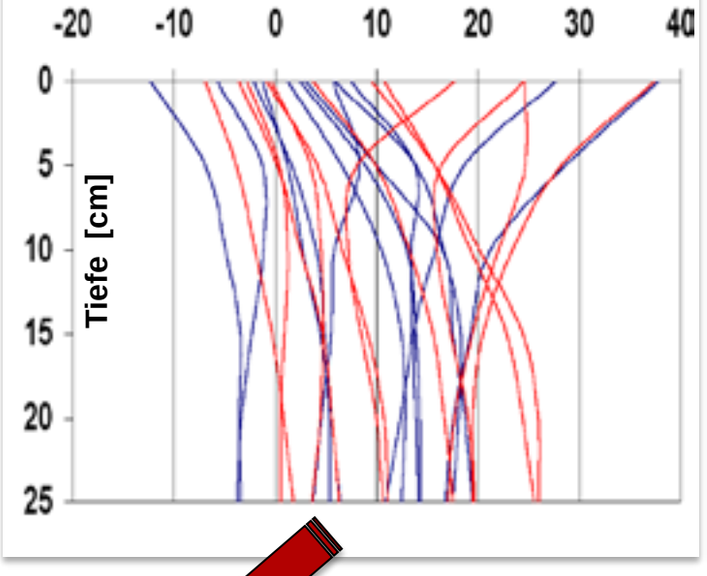


Axle load distribution

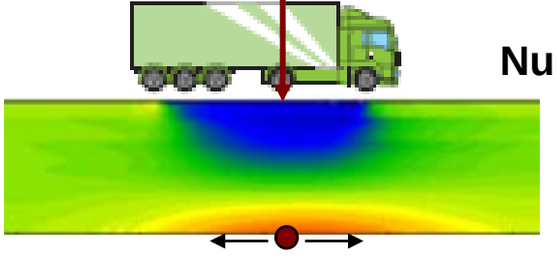
$$\mu_i(W) = \beta_i + \alpha_i W$$

traffic & climate

Temperature distribution in the asphalt [°C]



Axle load

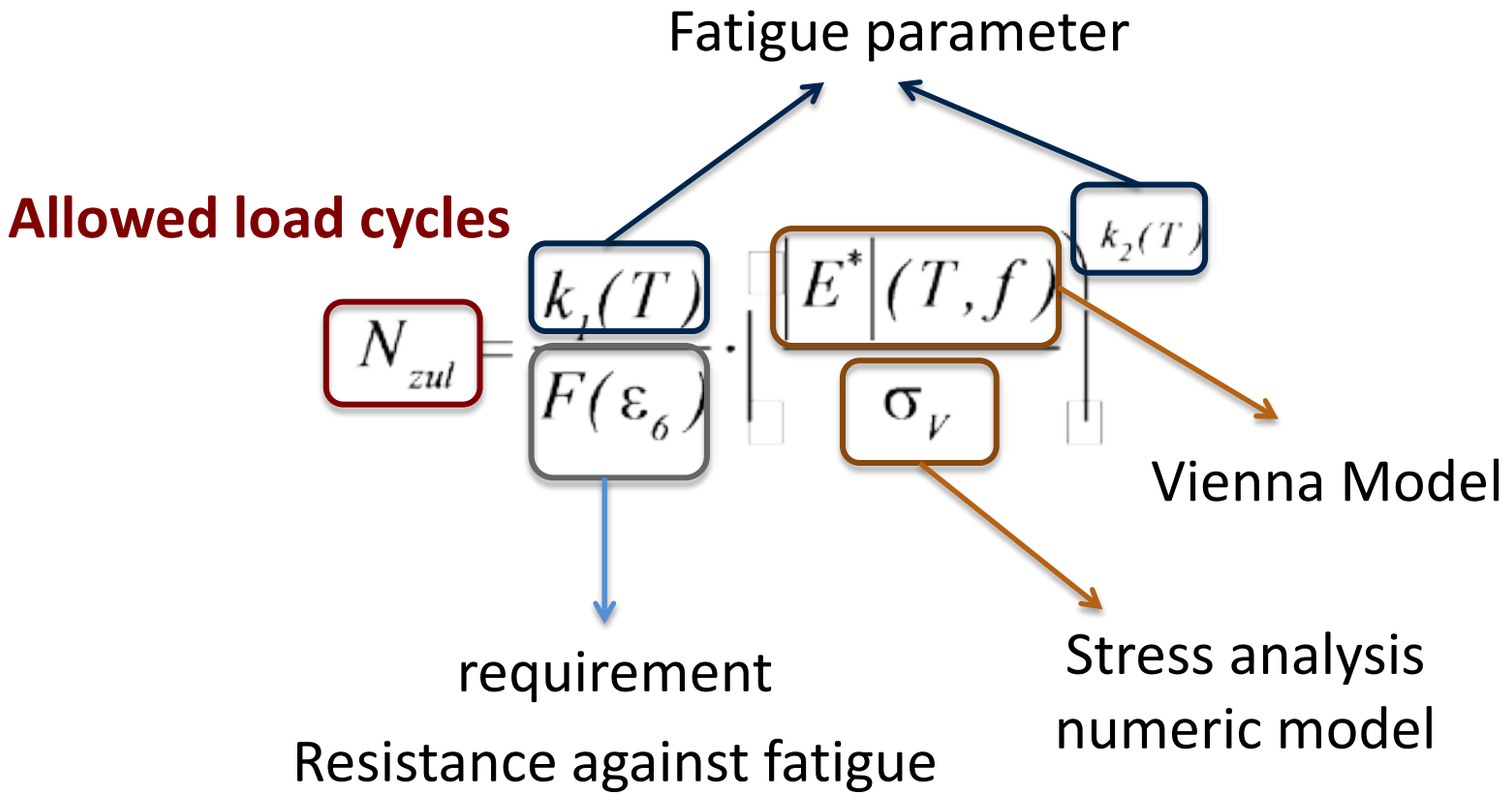


Numeric Model

σ_i

Numeric Model

Fatigue criteria



Calculation of the allowed load cycles until the pavement failure

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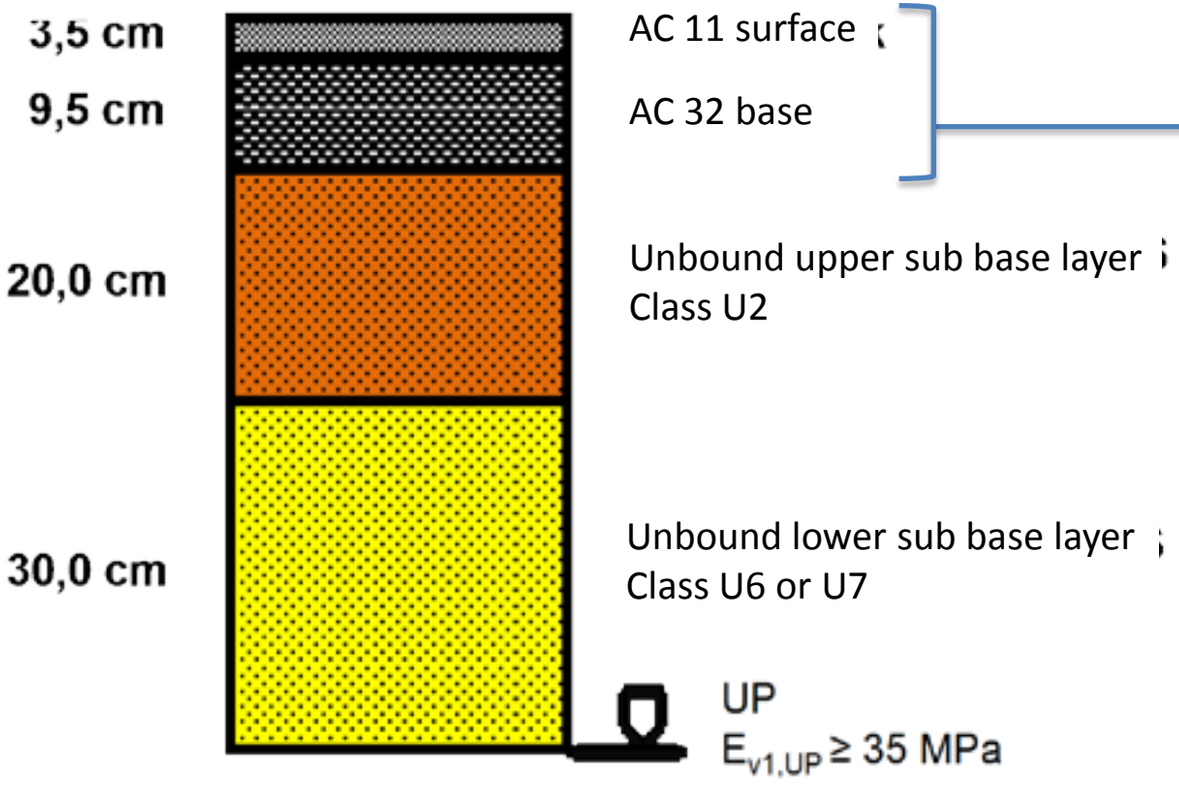
Example

Load class 0,4

Pavement structure



Variant

- 70/100
- PmB 45/80-65
- PmB 45/80 RC

Example

Load class 0,4

Calculation of the life time until the pavement fails

Thickness of the asphalt pavement: 13 cm / LK04 acc. RVS 03.08.63

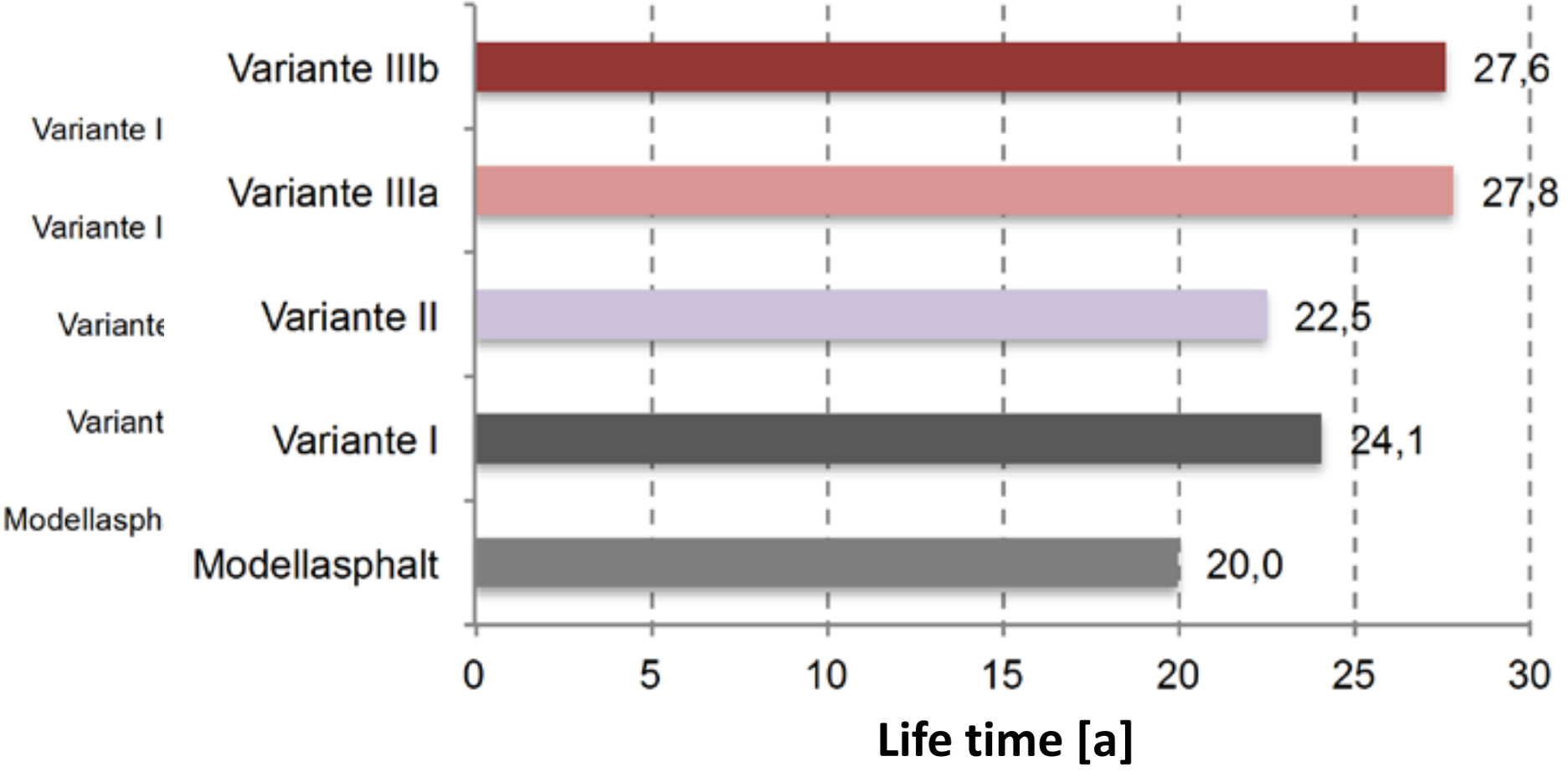
- Model asphalt acc. to catalogue

Variant I:	3,5 cm	AC 11 surf	70/100
	9,5 cm	AC 32 base	70/100
Variant II:	3,5 cm	AC 11 surf	PmB 45/80-65
	9,5 cm	AC 32 base	70/100
Variant IIIa:	3,5 cm	AC 11 surf	PmB 45/80-65
	9,5 cm	AC 32 base	PmB 45/80-65
Variant IIIb:	3,5 cm	AC 11 surf	PmB 45/80-65
	9,5 cm	AC 32 base	PmB 45/80 RC+ 20% RAP

Example

Load class 0,4

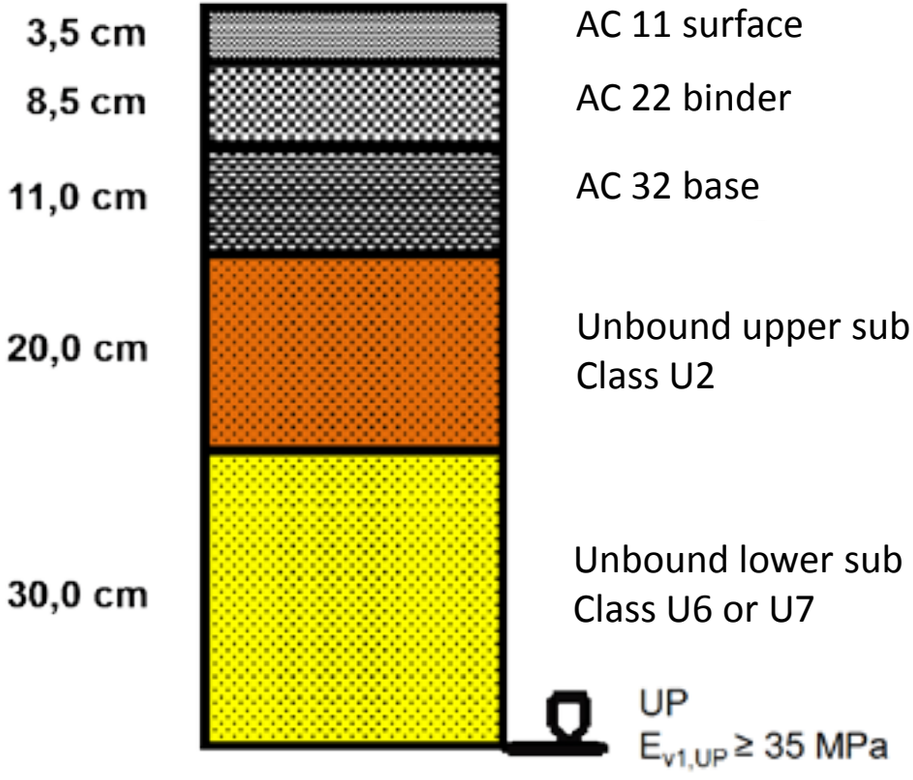
Calculation of the life time until the pavement fails



Example

Highway load class 10

Pavement structure



→ Variant

- 70/100
- PmB 45/80-65
- PmB 25/55-65
- PmB 45/80 RC

Example

Highway load class 10

Calculation of the life time until the pavement fails

Thickness of the asphalt pavement: 23 cm

- Model asphalt catalogue

Variant I:	3,5 cm	AC 11 surface	70/100
	8,5 cm	AC 22 binder	70/100
	11,0 cm	AC 32 base	70/100
Variant II:	3,5 cm	AC 11 surface	PmB 45/80-65
	8,5 cm	AC 22 binder	70/100
	11,0 cm	AC 32 base	70/100
Variant IIIa:	3,5 cm	AC 11 surface	PmB 45/80-65
	8,5 cm	AC 22 binder	PmB 45/80-65
	11,0 cm	AC 32 base	70/100
Variant IIIb:	3,5 cm	AC 11 surface	PmB 45/80-65
	8,5 cm	AC 22 binder	PmB 25/55-65
	11,0 cm	AC 32 base	70/100

Example

Highway load class 10

Calculation of the life time until the pavement fails

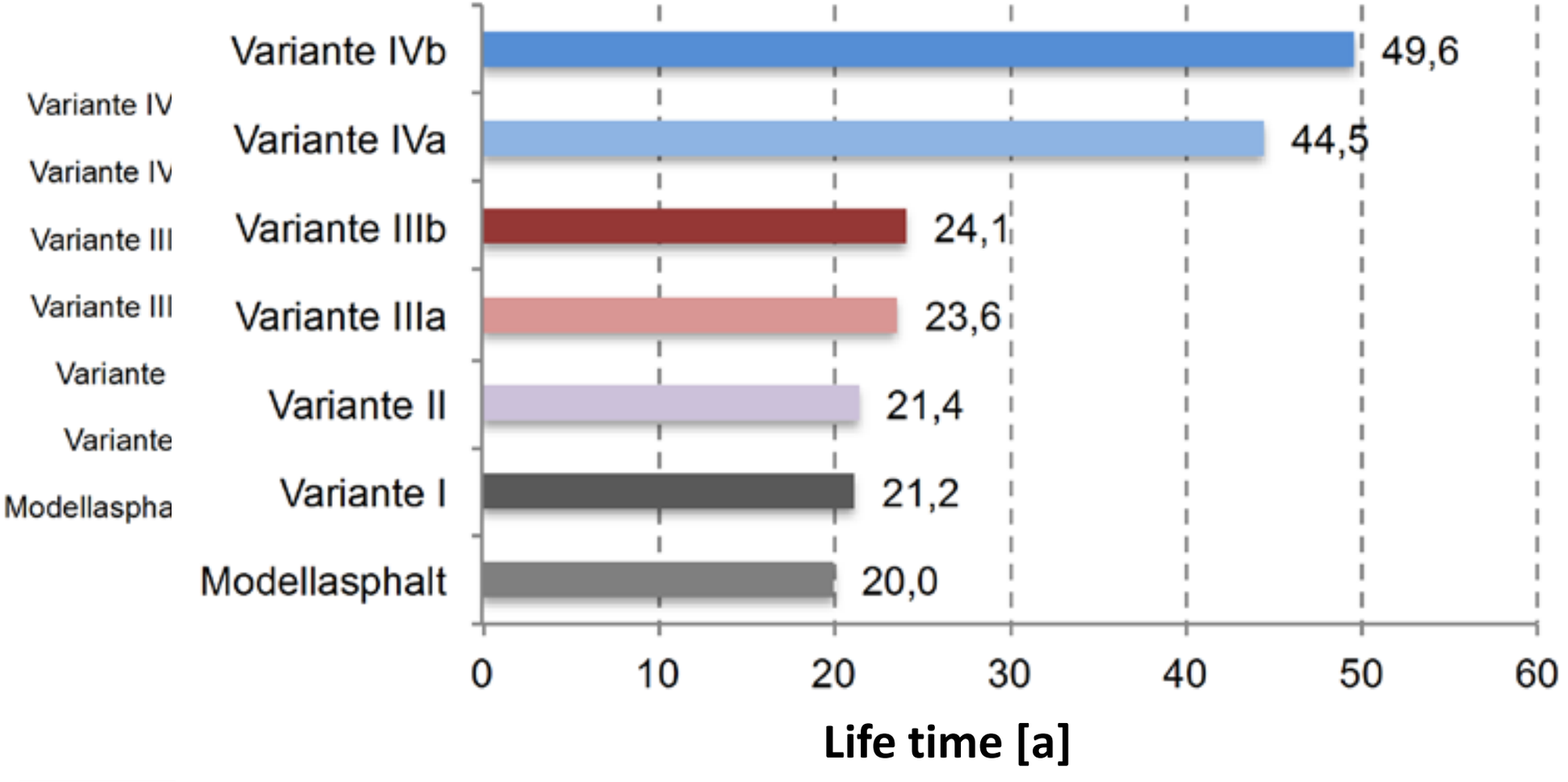
Thickness of the asphalt pavement: 23 cm

▶ Variant IVa:	3,5 cm	AC 11 surface	PmB 45/80-65
	8,5 cm	AC 22 binder	PmB 45/80-65
	11,0 cm	AC 32 base	PmB 45/80-65
▶ Variant IVb:	3,5 cm	AC 11 surface	PmB 45/80-65
	8,5 cm	AC 22 binder	PmB 25/55-65
	11,0 cm	AC 32 base	PmB 45/80-65

Example

Highway load class 10

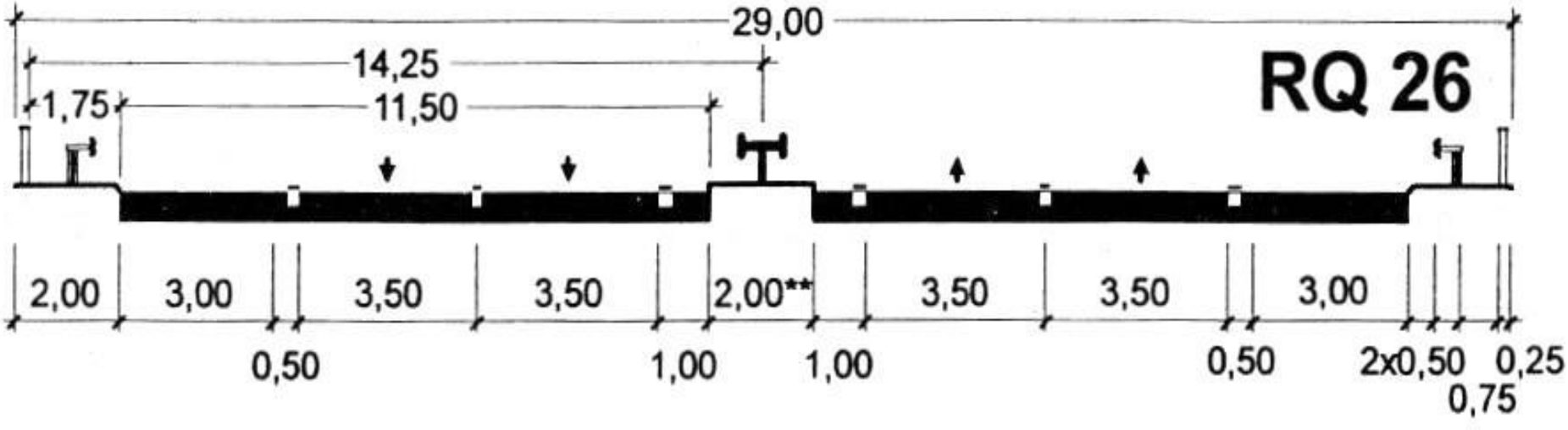
Calculation of the life time until the pavement fails



Highway class 10 – simplified LCI

- **Dimension:**

Capacity	Class 10 (heavy loaded traffic)	
Thickness	23,0 cm (3 layers of asphalt)	
Wideness	23 m (asphalt)	
Budget (var. I)	820.000 €	1 km length
Asphalt	12.050to (565 to Bitumen)	



Simplified LCI comparison

	variant 1	EUR/km	**variant 2**	EUR/km	**variant 3**	EUR/km
surface 3,5 cm	AC 11 surf **PmB**, A1, G2		AC 11 surf **PmB**, A2, G1		AC 11 surf **PmB**, A2, G1	
layer bonding	emulsion with PmB (0,2 kg/m²)		emulsion with PmB (0,2 kg/m²)		emulsion with PmB (0,2 kg/m²)	
binder 8,5 cm	AC 22 base **70/100**, T1, G4		AC 22 binder **PmB**, H1, G4		AC 32 binder **PmB**, H1, G4	
layer bonding	emulsion with PgB (0,2 kg/m²)		emulsion with PmB (0,2 kg/m²)		emulsion with PmB (0,2 kg/m²)	
base 11,0 cm	AC 32 base **70/100**, T1, G4		AC 32 base **70/100**, T1, G4		AC 32 binder **PmB**, H1, G4	
life time	**21 years**		**24 years**		**30 years**	
initial costs	production + paving	817.650	production + paving	850.540	production + paving	885.960
1. maintenance	surface layer after 8 years	160.080	surface layer after 9 years	160.080	surface layer after 10 years	160.080
2. maintenance	surface/binder after 15 years	458.390	surface/binder after 17 years	491.280	surface/binder after 20 years	491.280
3. maintenance	new construction after 21 years		new construction after **24 years**		new construction after **30 years**	
costs		**1.436.120**		**1.501.900**		**1.537.320**

Not included: costs per maintenance like limited availability of road, Rerouting of traffic, Milling of the asphalt, Cleaning and drying, Apply new road marking

Production: aggregates, energy, manpower, plant, rent, loader, heating oil, company,…

Paving: transport, paving, manpower, machines, rent, company,…

Resume

- Know the bearing capacity of your subgrade and the unbound layers (don't over estimate them)
- Take the impact of moisture and frost into consideration
- Do performance related tests (fatigue and dynamic stiffness tests)
- Use proper Bitumen types
- Change design process and take the real properties of the asphalt mixtures into consideration (higher quality - longer life time – less maintenance costs)

Outlook

- Life cycle costs analysis
- Impact of RAP and special bituminous binder (OMV Starfalt PMB RC)
- Road design with other bituminous binder types
- Additional load class

Questions?

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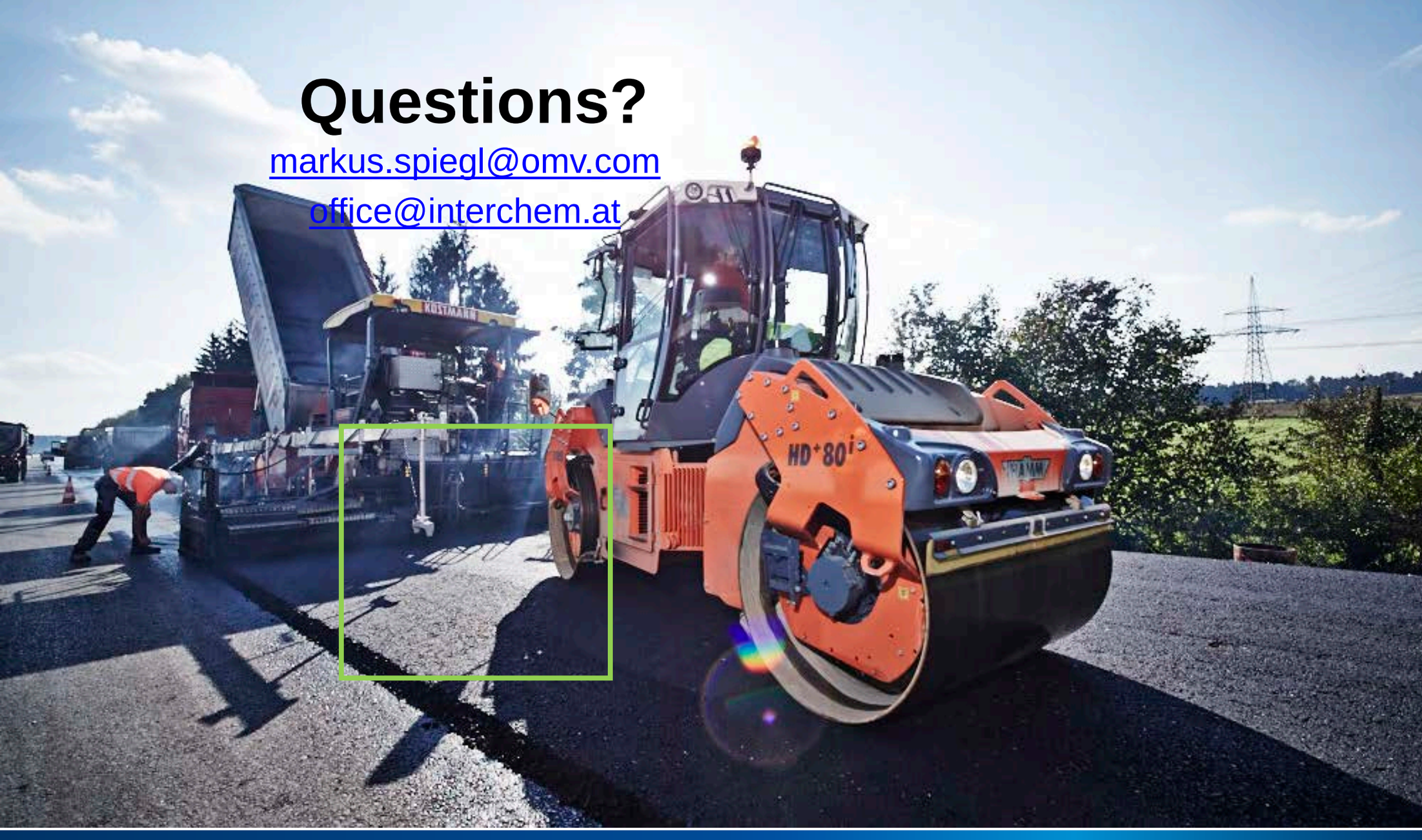

OMV STARFALT HIGH PERFORMANCE BITUMEN

Interchem

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