Hrvatsko asfaltersko društvo Croatian asphalt association

Analiza troškova tijekom životnog vijeka i utjecaj kvalitete bitumena

LCCA and the impact of bitumen quality

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Međunarodni seminar ASFALTNI KOLNICI 2017

International seminar ASPHALT PAVEMENTS 2017

Opatija, 05.–06. 04. 2017.

Content

- Recap 2016 presentation
  - Utjecaj kvalitete bitumena u novom postupku projektiranja asfaltnih kolnika u Austriji (The influence of the bitumen quality in new Austrian asphalt pavement design)
- Additional product – pavement design result
- Life Cycle Costs Analysis LCCA
  - Examples – Highway (load class 10)
- Resume
- Outlook

Recap of 2016 – 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**

Recap of 2016 – New Austrian asphalt pavement design - Stiffness – Vienna Model

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

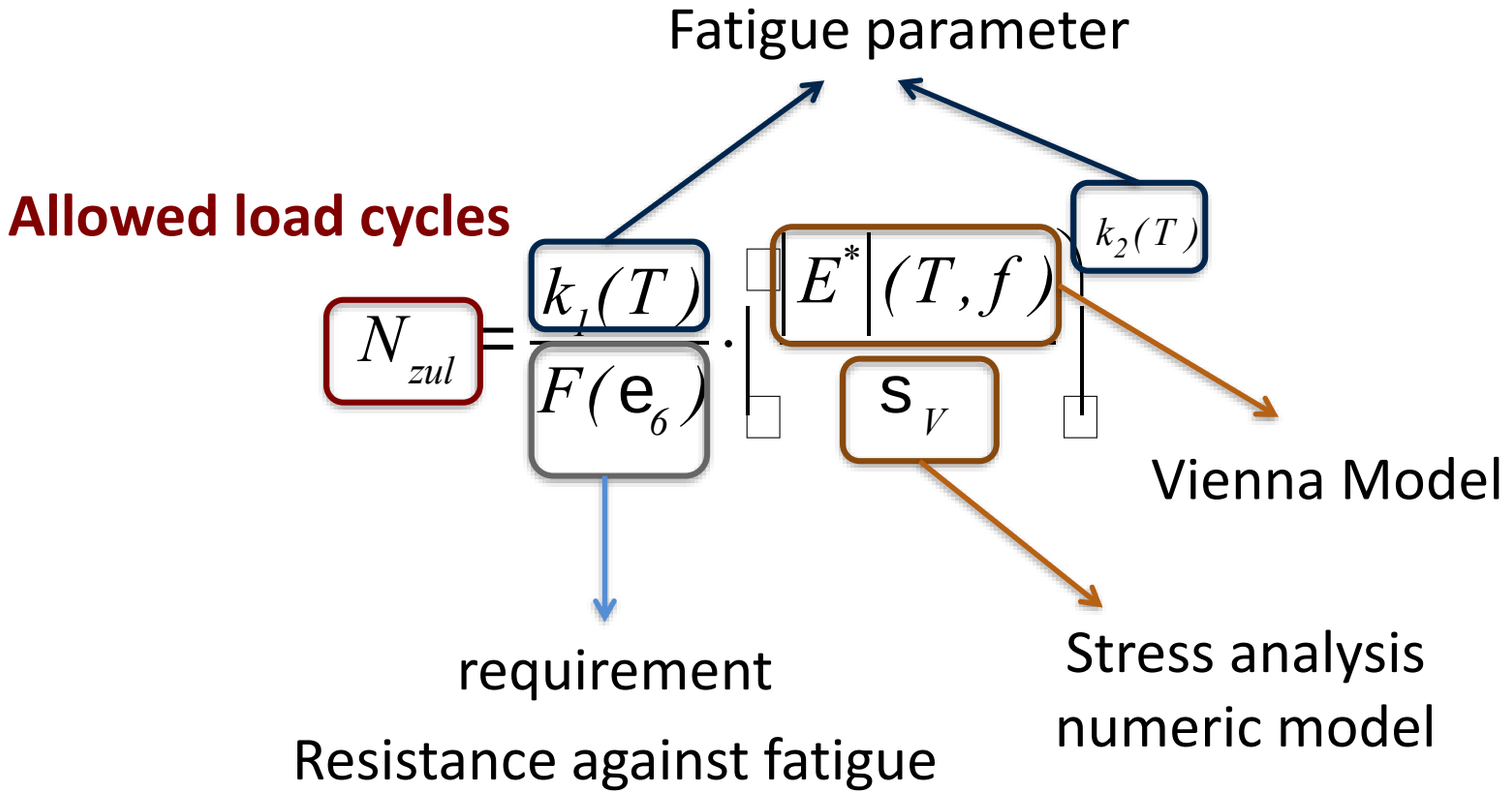
$$+ \frac{(1 - p_c)}{145{,}0377} \cdot \left[\frac{1 - \frac{VMA}{100}}{a} + \frac{VMA}{VFB \cdot 145{,}0377 \cdot 3 \cdot |G^*_{bit}|(T)} \right]^{-1}$$

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

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

Recap of 2016 – Numeric Model

Fatigue criteria

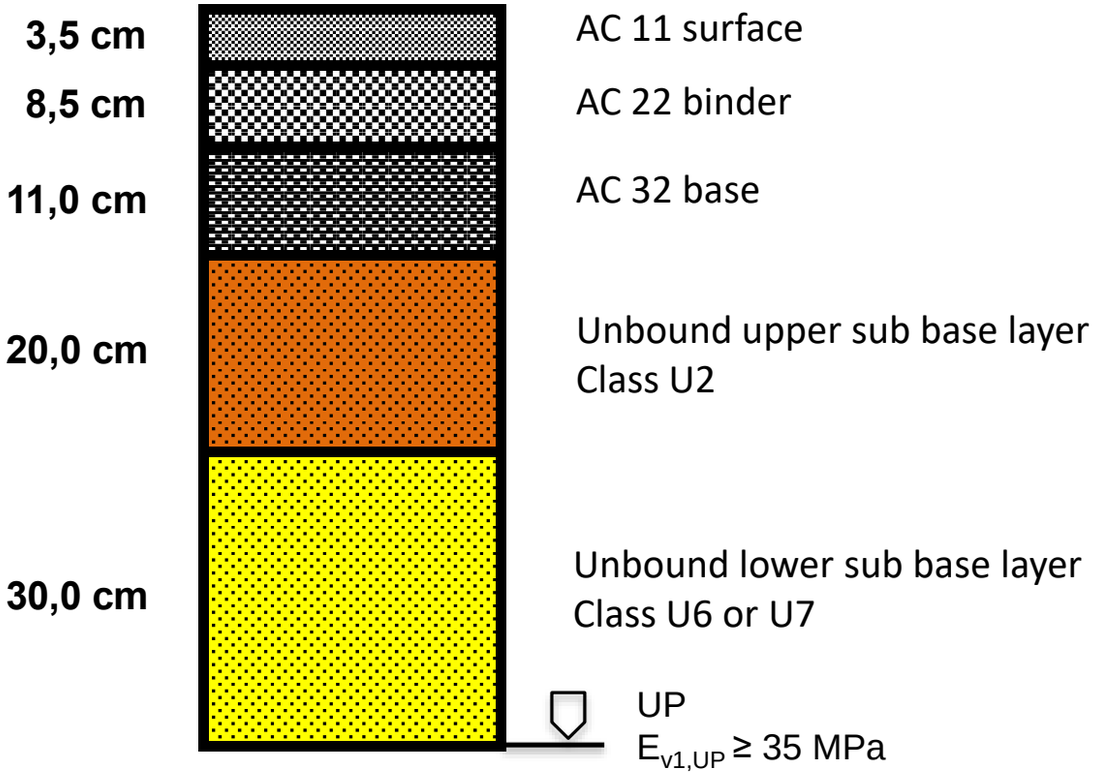


Calculation of the allowed load cycles until the pavement failure

Recap of 2016 – Example

Highway load class 10

Pavement structure



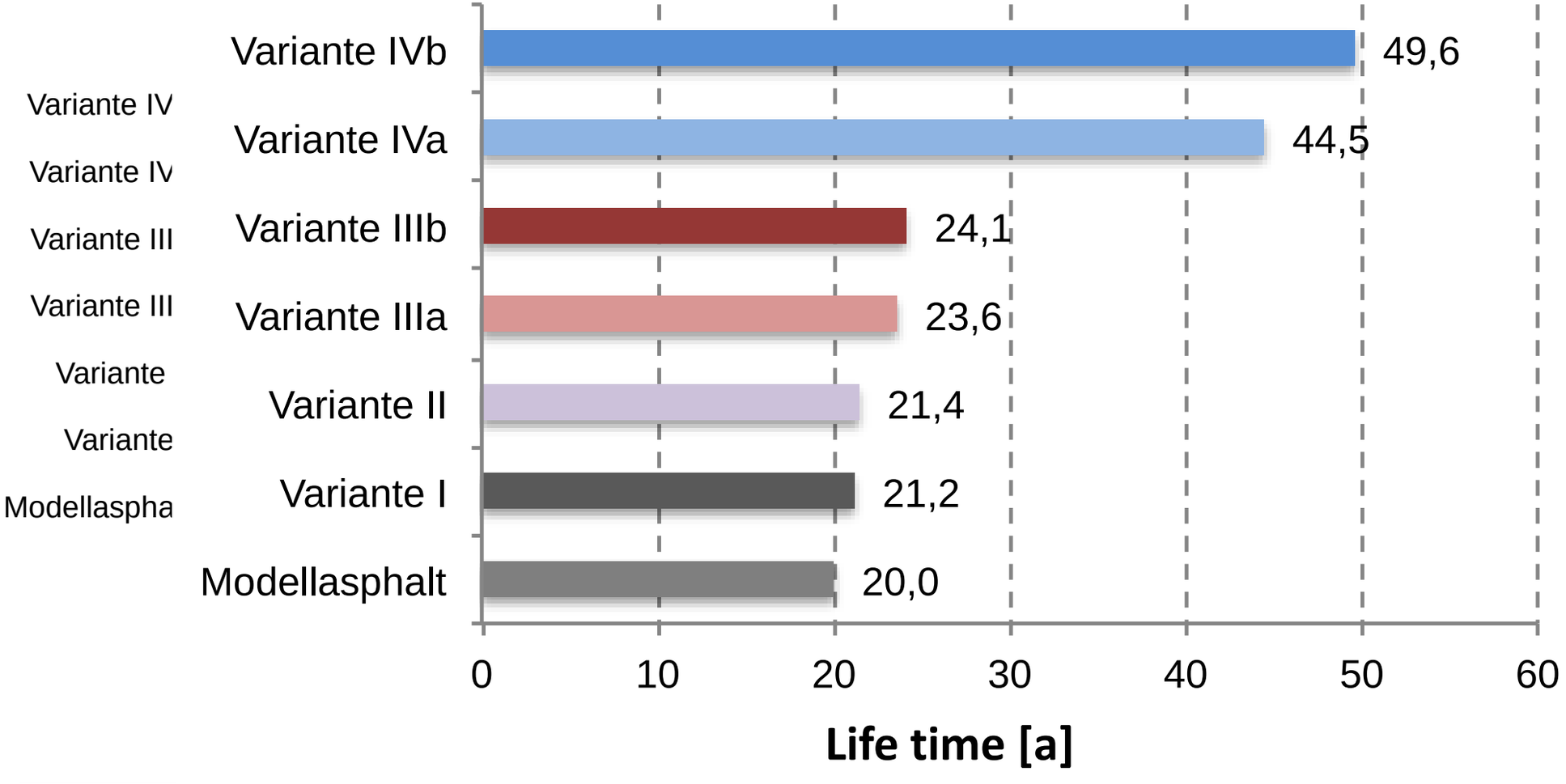
→ Variant

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

Recap of 2016 – Example

Highway load class 10

Calculation of the life time until the pavement fails



Additional product

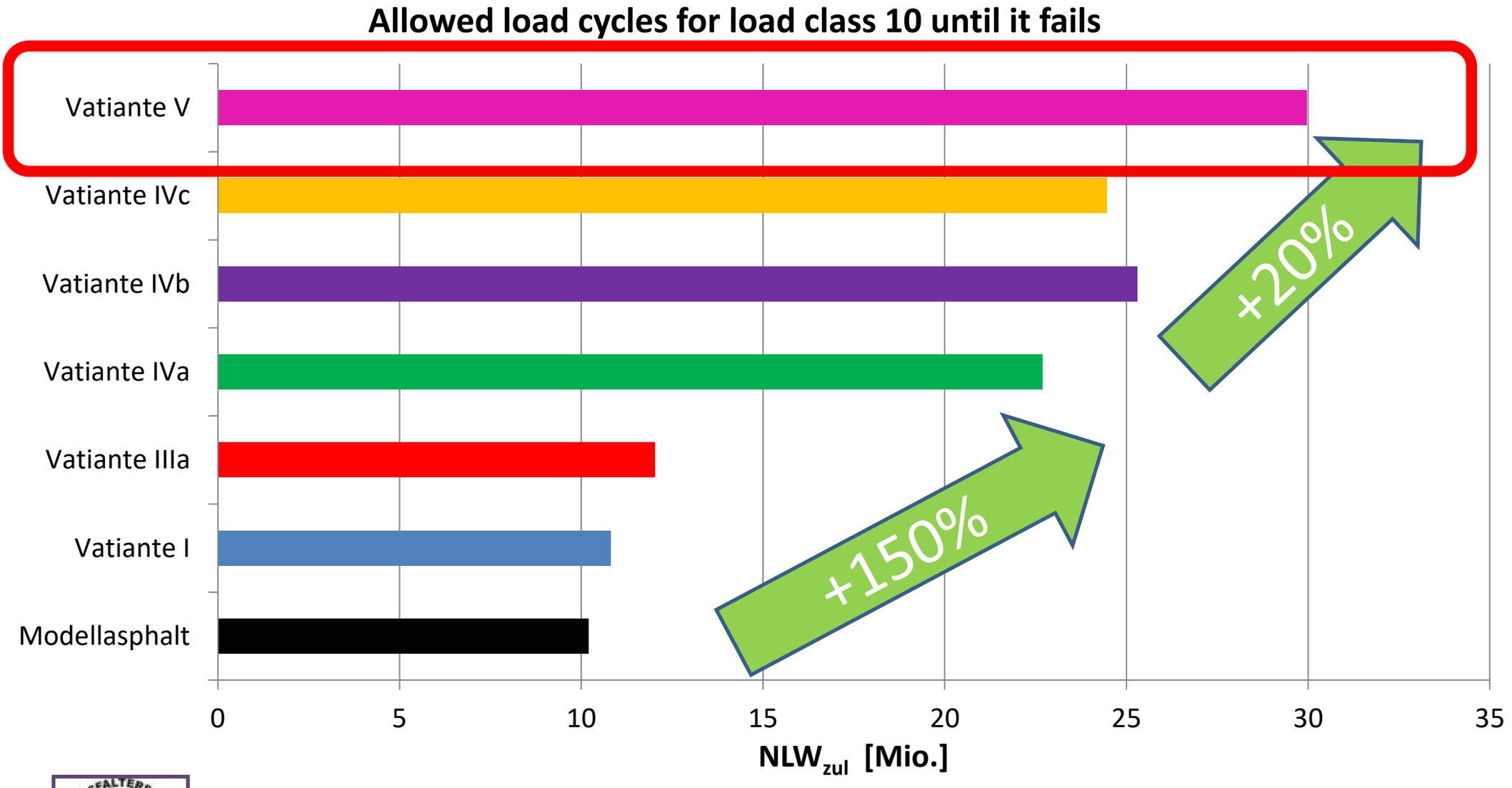
Bituminous binder properties

PmB HiM – OMV Starfalt® PmB 45/80-80

Type of Binder acc. EN 14023		OMV Starfalt® PmB 25/55-65	45/80-65	45/80 RC	PmB HiM
Requirement / Characteristic	**Unit**	**Range of Values**			
Penetration at 25°C	x0.1 mm	25 - 55	45 - 80	45 - 80	45-80
Softening point	°C	≥ 65	≥ 65	≥ 70	≥ 80
Force ductility	J/cm²	≥ 3 (5°C) ≥ 3 (10°C)	≥ 3 (5°C)	≥ 3 (5°C)	≥ 3 (10°C)
Mass change at 163°C	%	≤ 0,5	≤ 0,5	≤ 0,5	≤ 0,5
Retained penetration	%	≥ 60	≥ 60	≥ 60	≥ 60
Increase in softening point	°C	≤ 8	≤ 8	≤ 8	≤ 8
Flash point	°C	≥ 250	≥ 250	≥ 250	≥ 250
Fraass breaking point	°C	≤ – 12	≤ – 18	≤ – 18	≤ – 20
a Elastic recovery (25°C)	%	≥ 80	≥ 80	≥ 80	≥ 80 (95)
Storage stability - difference in softening point	°C	≤ 5	≤ 5	≤ 5	≤ 5
Elastic recovery (25°C) acc. to EN 12607	%	≥ 60	≥ 70	≥ 70	≥ 70 (80)

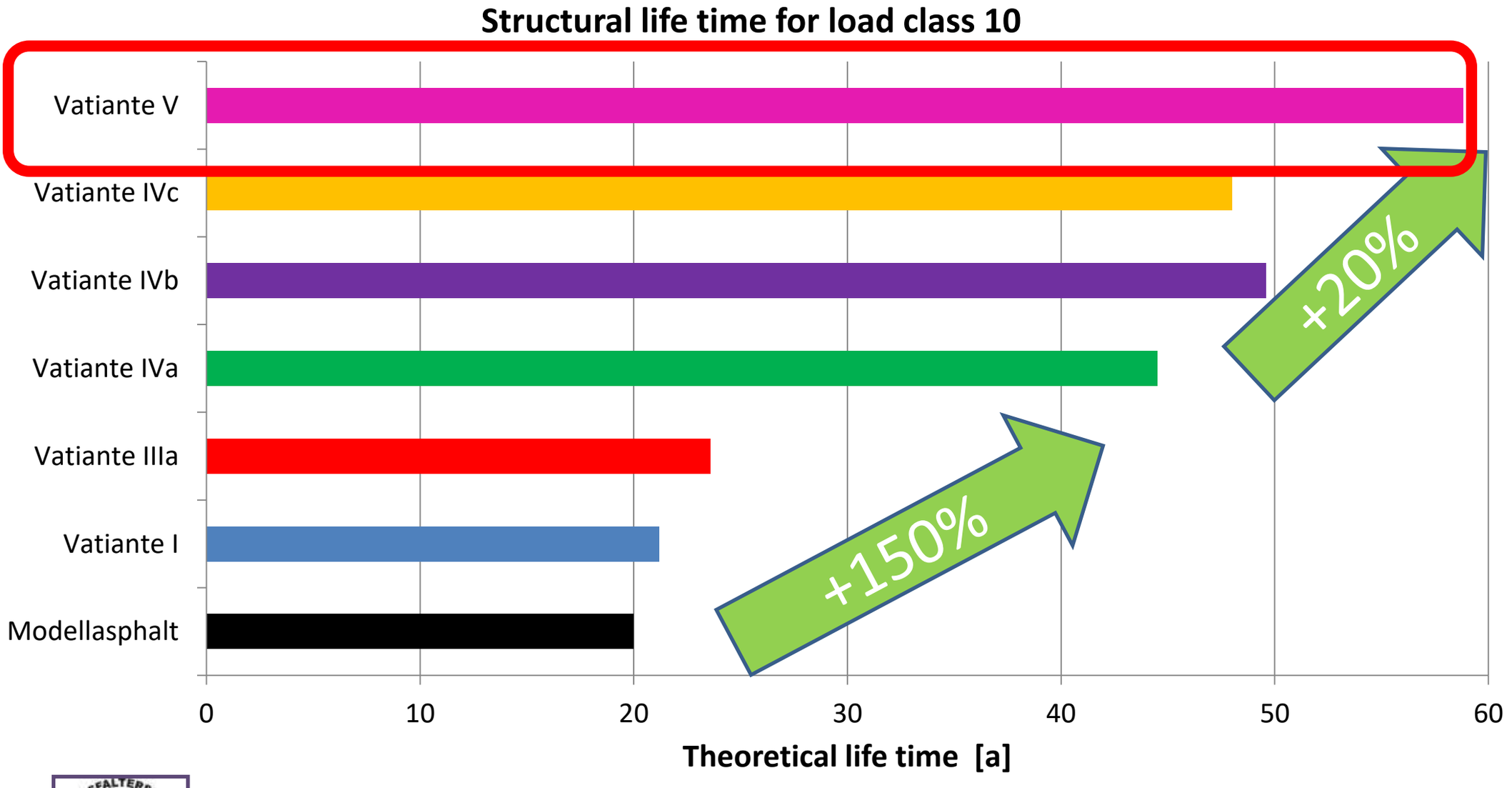
Additional product

Pavement Design results



Additional product

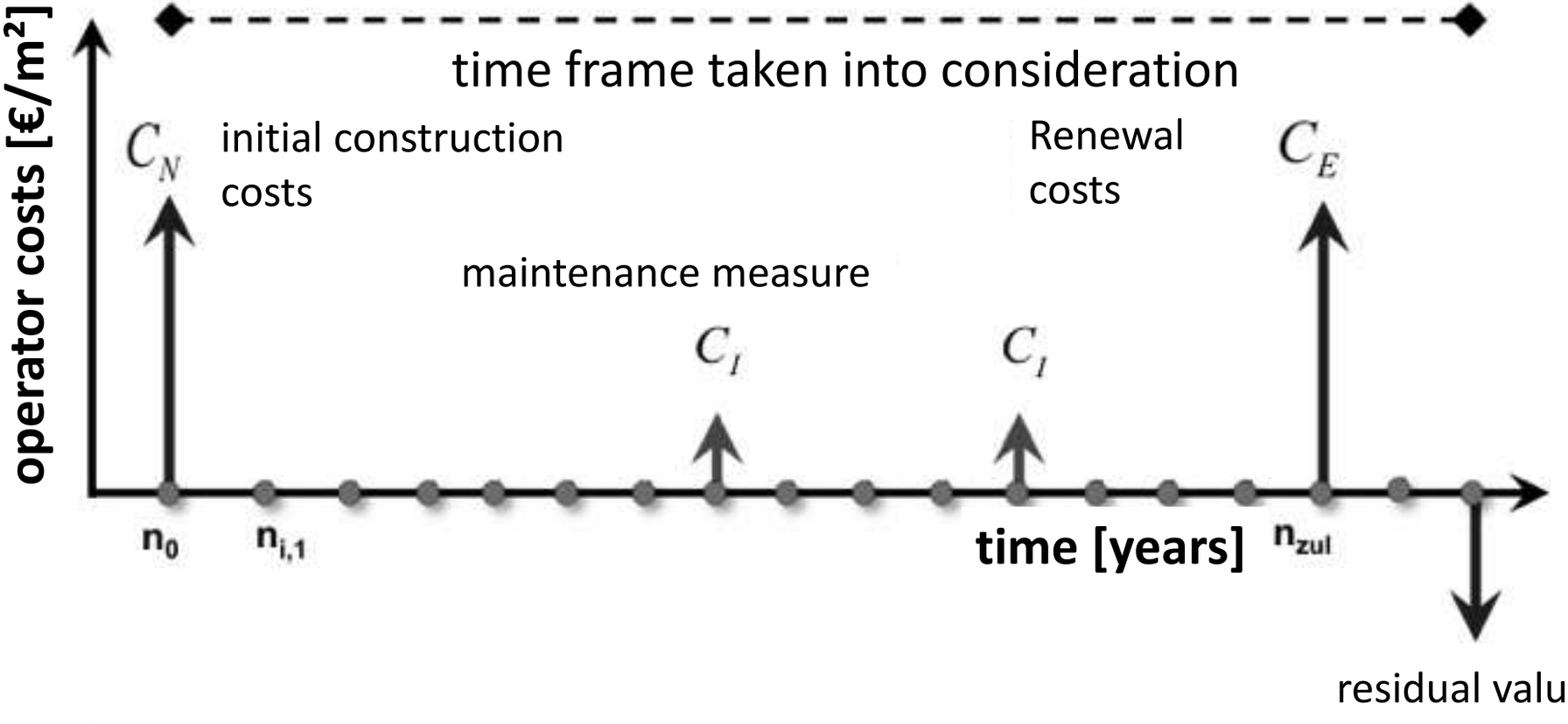
Pavement Design results



Life Cycle Costs Analysis – LCCA

Methodology

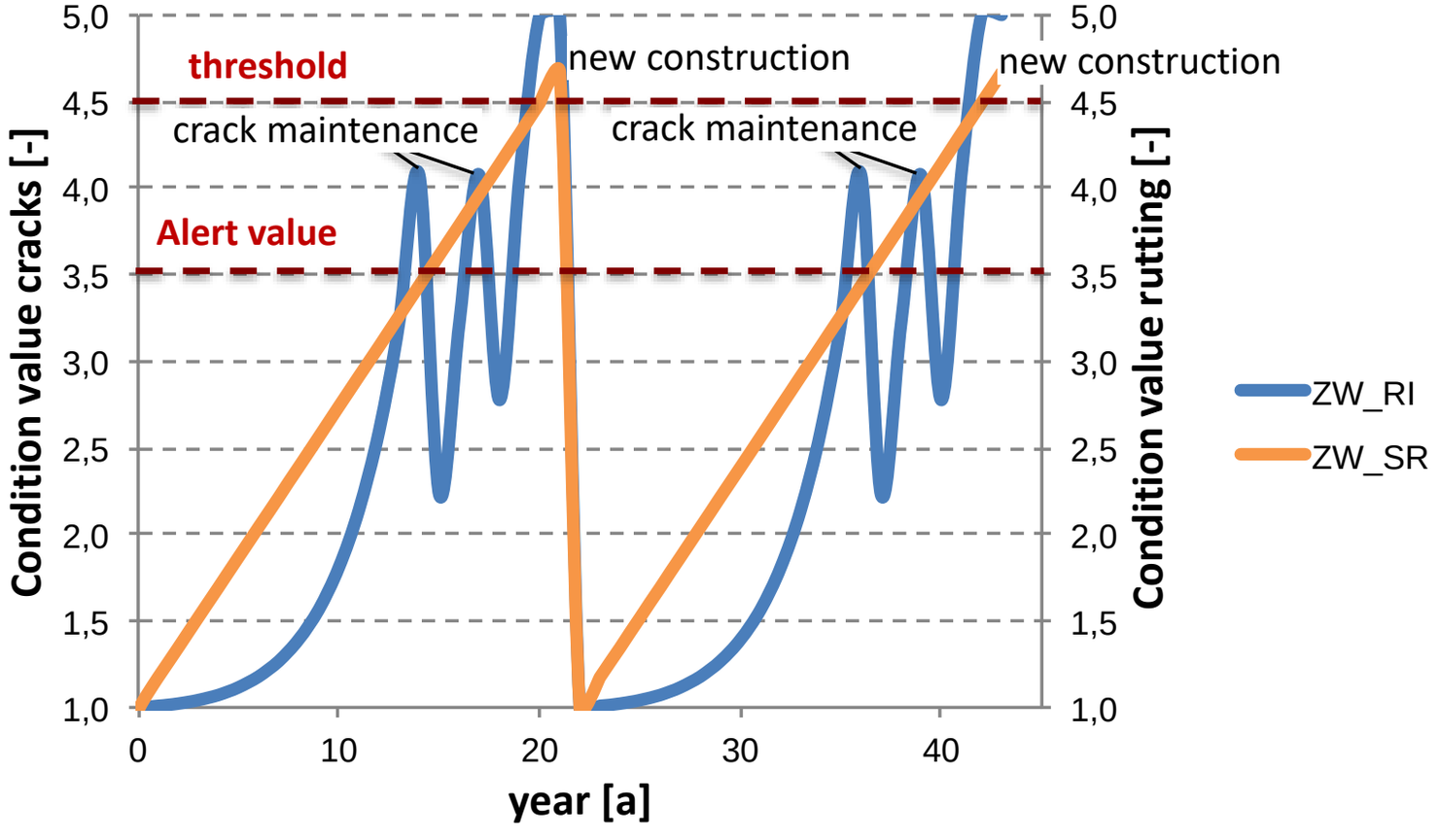
- Consideration of pavements for initial construction, maintenance , renewal and residual value at the end of the life cycle (public easement costs)
- Calculation of **net present value & annuity**



Life Cycle Costs Analysis – LCCA

Simulation of the condition development

Main failure characteristics are cracks and deformation/rutting

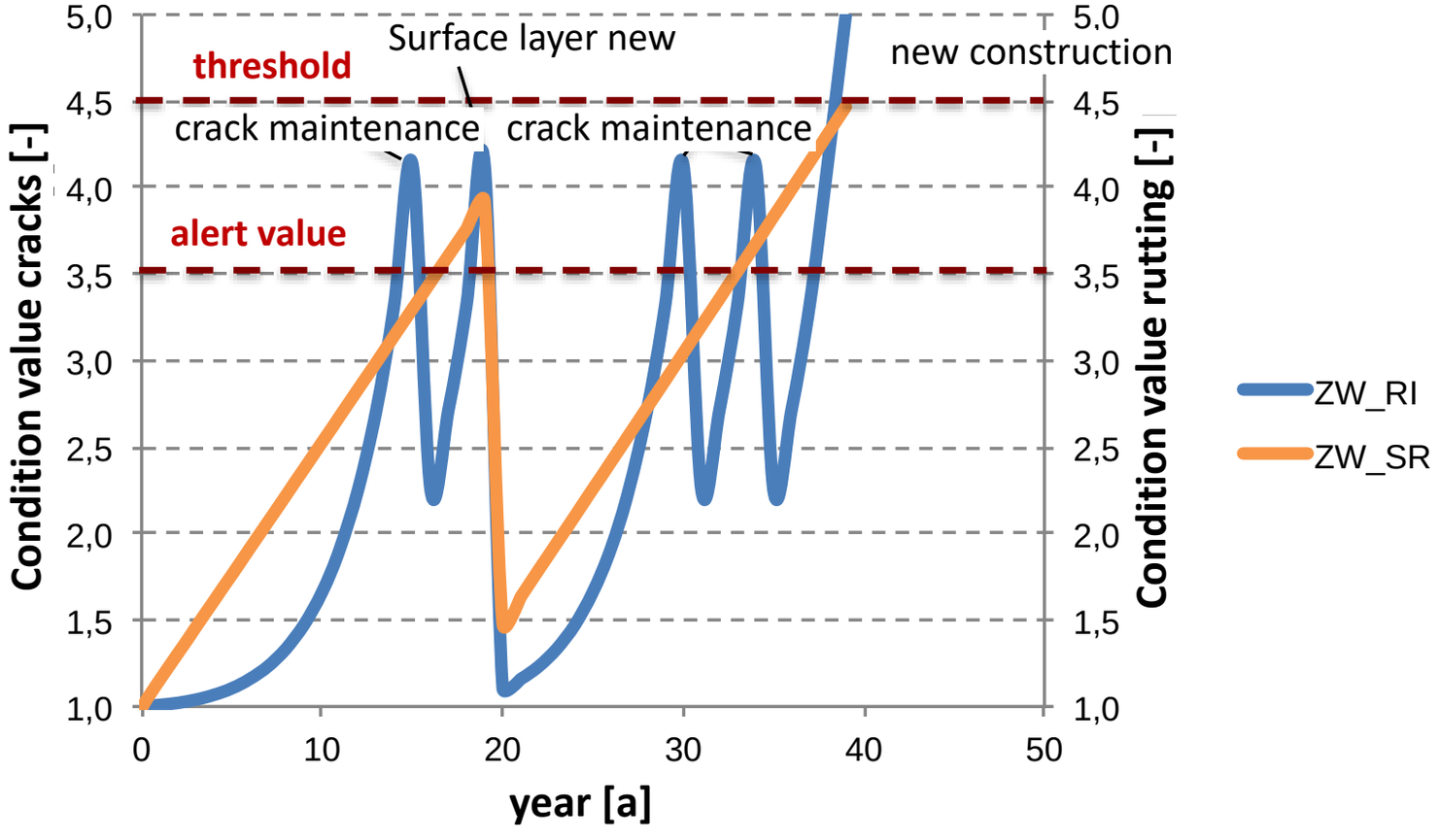


Construction type AS1-LC10, Variant I - pavement with paving grade bitumen

Life Cycle Costs Analysis – LCCA

Simulation of the condition development

Main failure characteristics are cracks and deformation/rutting



Construction type AS1-LC10, Variant IV - asphalt pavement with PmB

Life Cycle Costs Analysis – LCCA

Standard cycles in the consideration period

Construction type AS1-LC10

Time frame of 50 years were taken into consideration

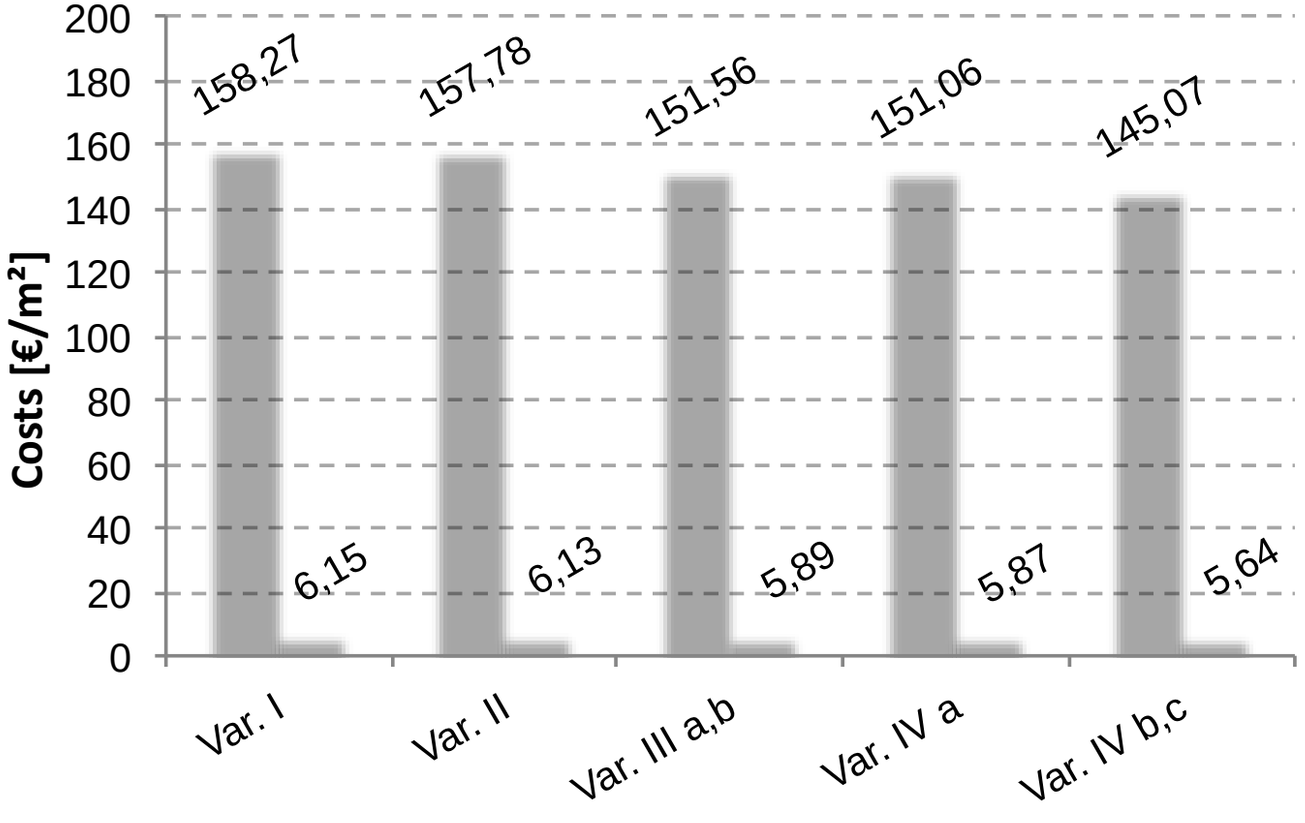
Variant	description	maintenance measure			reconstruction of bit. bound pavement	residual value after 50 years (bit. bound pavement)
		crack maintenance		reconstruction surface layer		
		year [a]	share [%]	year [a]	Year [a]	[%]
variant I	only PgB	13/17/36/39	8,8	-	22/43	66,7
variant II	surface layer with PmB	15/37	9,0	-	22/43	66,7
variant III a/b	surface and binder layer with PmB	15/40	9,0 / 6,6	20/45	24/50	100
variant IV a	only PmB	15/30/34	9,0	20	39	71,8
variant IV b/c		15/30/34/39	9,0	20	44	86,4

Life Cycle Costs Analysis – LCCA

Net present value & Annuity

Construction type AS1-LC10

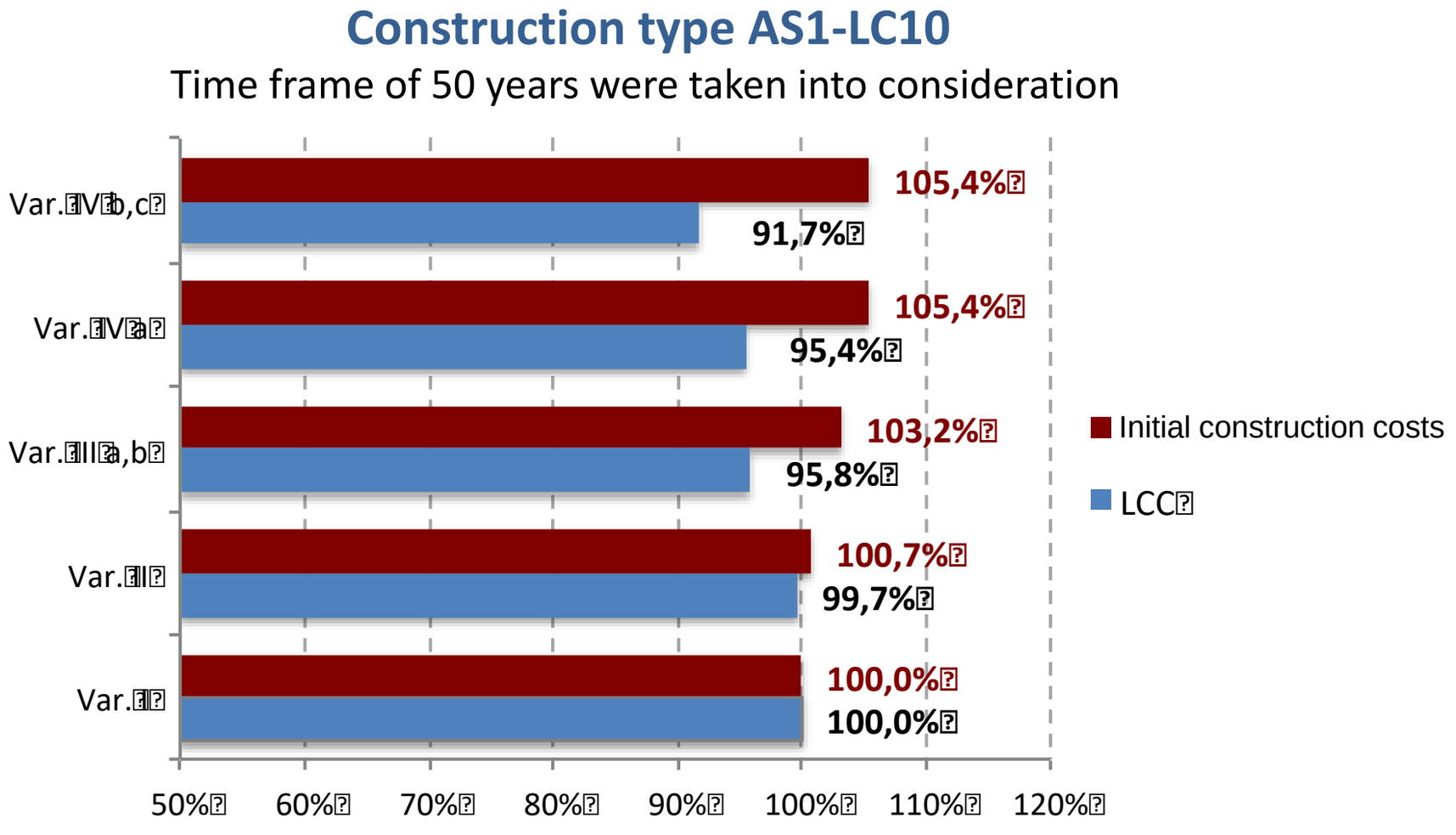
Time frame of 50 years were taken into consideration



Average prices (price base 2015, construction site bigger than 5.000 m^2), interest rate i = 3%

Life Cycle Costs Analysis – LCCA

Construction costs vs. Life Cycle Costs



Average prices (price base 2015, construction site bigger than 5.000 m^2), interest rate i = 3%

Resume

- Do **performance related tests** (fatigue and dynamic stiffness tests)
- Change design process and take the **real properties** of the asphalt mixtures into consideration (higher quality - longer life time – less maintenance)
- Bitumen **type and quality** has a **huge impact** on the **life span** of a pavement
- Significant **increase of life span** if **high quality PmB is used** for the whole pavement structure
- **LCCA is necessary** for a proper evaluation of initial construction costs
- Only PmB -> 5% higher initial costs but **8% less LCC**

CEE Road pavement design workshop 2016

- 3rd time (2008 – 2012 – 2016) – ZAS, Czech asphalt association and OMV
- Experts of 8 participating countries
- 42 participants
- Actual and future road design approach
- Project idea: international cooperation in road design (comparison of the various road design approaches)
- Next one in 2 or 4 years again
- More participants and more countries

CEE Road pavement design workshop 2016

Questions?

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OMV STARFALT HIGH PERFORMANCE BITUMEN

Interchem

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