



HEALROAD Symposium

ECONOMIC: LOW-COST PREVENTIVE MAINTENANCE TECHNIQUE (Life Cycle Cost Analysis)

Tobias PANWINKLER

Federal Highway Research Institute (BAST)

panwinkler@bast.de

Infravation
An Infrastructure Innovation Programme





Content

1. LCCA – Theoretical Background
2. Variants
3. Road Authority Costs
4. Socio-Economic Costs
5. Results
6. Conclusion





LCCA – Theoretical Background

LCCA:

→ Monetary Assessment of a construction taking into account its entire lifetime
 → decision criterion used not limited to production costs (net investments) but also all consequential costs (replacement investments)
 → alternatives can be compared
 → HEALROAD- vs. common porous Asphalt

Costs			
Road authority costs			
Construction <ul style="list-style-type: none"> • Costs per construction item • General construction costs • Operating expenses • Risk and Profit 	Maintenance <ul style="list-style-type: none"> • € / m² per anno 	Repair <ul style="list-style-type: none"> • Measures at fixed intervals • Measures when reaching breakdown criteria 	Salvage (residual) value <ul style="list-style-type: none"> • Costs to restore original conditions
		Renewal <ul style="list-style-type: none"> • Fixed • Reaching criteria 	

Costs		
Road user and social costs		
Road user costs <ul style="list-style-type: none"> • Caused by worsening surface conditions • Caused by measures 		Social costs <ul style="list-style-type: none"> • Noise • Pollution • Climate
Caused by worsening surface conditions <ul style="list-style-type: none"> • Travel speed • Accident frequency • Energy consumption 	Caused by measures <ul style="list-style-type: none"> • Travel time • Traffic holdup • Energy consumption • Accident frequency • Climate 	



LCCA Variants

HEALROAD Asphalt Variants

- D Asphalt surface course 12 cm**
- D4 HEALROAD Asphalt*
concrete wearing course 5 cm
- D3 Tack coat*
- D2 Asphalt binder course 7 cm*
- D1 Tack coat*

Line	Load class	BK100			
	B [million of ESALs]	> 32			
	Thickness of frost resistant pavement structure ¹⁾	55	65	75	85
Asphalt base course and crushed rock					
3	D Asphalt surface course 12 cm				
	C Asphalt base course 18 cm				
	B Crushed rock base course ⁷⁾ 15 cm $E_{v2} \geq 150(120)$				
	A Frost blanket course 10 cm				
	Thickness of frost blanket course	-	-	30 ²⁾	40

COMPARING Asphalt Variants

- D Asphalt surface course 12 cm**
- D4 Porous Asphalt*
concrete wearing course 5 cm
- D3 Tack coat*
- D2 Asphalt binder course 7 cm*
- D1 Tack coat*

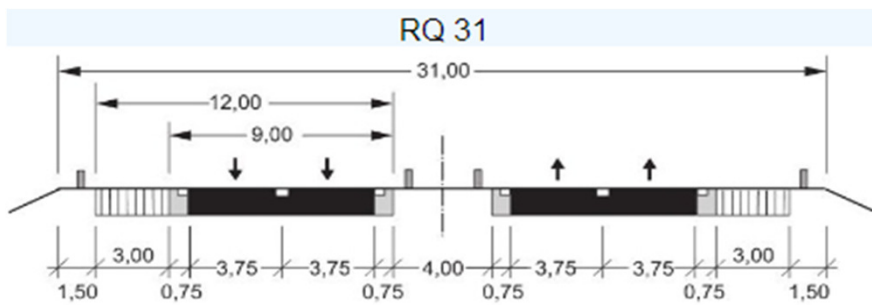




LCCA Variants

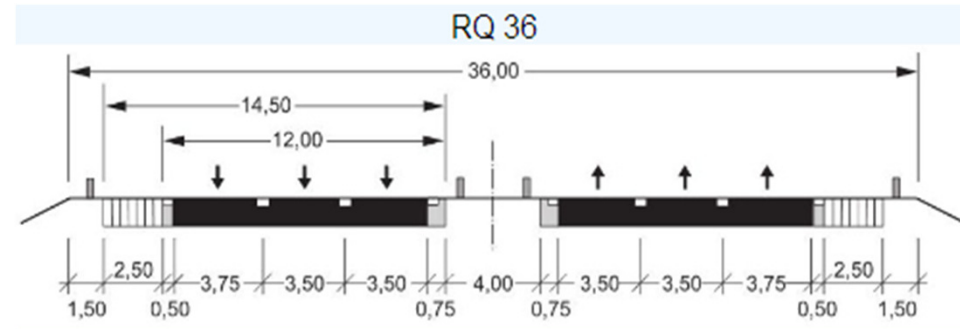
RQ 31

Motorway with:
2 driving lanes and
one marginal strip per direction



RQ 36

Motorway with:
3 driving lanes and
one marginal strip per direction





LCCA Variants

Four LCCA were performed within Healroad Project

German motorway with German standard cross-sections

- Healroad asphalt and RQ 31 (two lanes per direction)
- Healroad asphalt and RQ 36 (three lanes per direction)
- Comparing asphalt and RQ 31 (two lanes per direction)
- Comparing asphalt and RQ 36 (three lanes per direction)

30 year period – common asphalt exchanged after 10 years,

HEALROAD asphalt exchange after 15 years with two induction heating measures





Road Authority Costs

Healroad variants with higher construction costs
 BUT lower costs for renewal measures

	Healroad Asphalt				Comparing Asphalt			
	RQ31		RQ36		RQ31		RQ36	
	Costs per square-metre/ Kosten pro m ²	Costs per metre road/ Kosten pro Laufmeter	Costs per square-metre/ Kosten pro m ²	Costs per metre road/ Kosten pro Laufmeter	Costs per square-metre/ Kosten pro m ²	Costs per metre road/ Kosten pro Laufmeter	Costs per square-metre/ Kosten pro m ²	Costs per metre road/ Kosten pro Laufmeter
<i>Pavement markings /</i>								
	Healroad Asphalt				Comparing Asphalt			
	RQ31		RQ36		RQ31		RQ36	
	Share / Anteil	Costs for Anlysis Section/ Kosten Test-strecke	Share / Anteil	Costs for Anlysis Section/ Kosten Test-strecke	Share / Anteil	Costs for Anlysis Section/ Kosten Test-strecke	Share / Anteil	Costs for Anlysis Section/ Kosten Test-strecke
Sum of Costs for Analysis Section (10,000 m) Summe Einzelkosten der Teilleistungen für die Teststrecke (10.000 m)		9,119,304 €		10,975,891 €		8,928,592 €		10,785,579 €
<i>Share of construction site overhead costs /</i> Anteil Baustellengemeinkosten	5%	455,965 €	5%	548,795 €	5%	446,430 €	5%	539,279 €
Sum Construction costs / Summe Herstellungskosten		9,575,269 €		11,524,685 €		9,375,022 €		11,324,858 €
<i>Share of operating expenses /</i> Anteil allgemeine Geschäftskosten	12%	1,149,032 €	12%	1,382,962 €	12%	1,125,003 €	12%	1,358,983 €
Sum Prime costs / Summe Selbstkosten		10,724,301 €		12,907,648 €		10,500,024 €		12,683,841 €
<i>Share of risk and profit /</i> Anteil Wagnis und Gewinn	4%	428,972 €	4%	516,306 €	4%	420,001 €	4%	507,354 €
Net bis sum / Netto Angebotssumme		11,153,273 €		13,423,953 €		10,920,025 €		13,191,195 €





Socio-Economic Costs

Measure / Maßnahme	Year of Measure / Jahr der Maßnahme	MQ 31 - Healroad				MQ 36 - Healroad			
		Days needed for Measure	Add-itional Costs per Day	Additional Costs per Measure	Discounted Costs Rate 1.7 %	Days needed for Measure	Add-itional Costs per Day	Additional Costs per Measure	Discounted Costs Rate 1.7 %
		2023	104	113.15	11,767.60	10,457.82	104	50.21	5,221.84
"Healing" of main lane / "Heilen" des Hauptfahrstreifen	2028	104	118.20	12,292.80	10,041.52	104	23.23	2,415.92	1,973.47
	2038	104	129.16	13,432.64	9,270.44	104	56.78	5,905.12	4,075.38
	2043	104	135.13	14,053.52	8,914.96	104	59.19	6,155.76	3,904.95
Exchange wearing course Main Lane/ Austausch Deckschicht Tiefeinbau HFS	2031	20	3,719.15	74,383.00	57,764.28	20	10,865.00	217,300.00	168,750.64
	-	0	0.00	0.00	0.00	0	0.00	0.00	0.00
Exchange wearing course Overtaking Lane(s)/ Austausch Deckschicht Tiefeinbau ÜFS	2031	20	3,719.15	74,383.00	57,764.28	37.3	10,865.00	405,264.50	314,719.95
User Costs caused by Measures/ Maßnahmenbedingte Nutzerkosten				154,213.31 €				498,065.02 €	

Healroad variants with less S.-E. costs

Measure / Maßnahme	Year of Measure / Jahr der Maßnahme	MQ 31 - Compare				MQ 36 - Compare			
		Days needed for Measure	Add-itional Costs per Day	Additional Costs per Measure	Discounted Costs Rate 1.7 %	Days needed for Measure	Add-itional Costs per Day	Additional Costs per Measure	Discounted Costs Rate 1.7 %
		-		0		0.00	0.00	0	
"Healing" of main lane / "Heilen" des Hauptfahrstreifen	-	0		0.00	0.00	0		0.00	0.00
	-	0		0.00	0.00	0		0.00	0.00
	-	0		0.00	0.00	0		0.00	0.00
Exchange wearing course Main Lane/ Austausch Deckschicht Tiefeinbau HFS	2026	20	3,504.42	70,088.40	59,215.67	20	9,897.00	197,940.00	167,233.79
	2036	20	3,979.37	79,587.40	56,810.06	20	12,023.00	240,460.00	171,642.09
Exchange wearing course Overtaking Lane(s)/ Austausch Deckschicht Tiefeinbau ÜFS	2031	20	3,719.15	74,383.00	57,764.28	37.3	10,865.00	405,264.50	314,719.95
User Costs caused by Measures / Maßnahmenbedingte Nutzerkosten				173,790.01 €				653,595.82 €	
Saving with Healroad / Ersparnis bei Healroad				-11.3%				-23.8%	





Results

Healroad variants are more cost-efficient by 4%

	Healroad Asphalt		Comparing Asphalt		Healroad vs. Comparing	
	RQ31	RQ36	RQ31	RQ36	RQ31	RQ36
Net Bid Sum for Construction of Analysis Section (10,000 m) Netto Angebotssumme Errichtung der Teststrecke (10.000 m)	11,153,273 €	13,423,953 €	10,920,025 €	13,191,195 €	+2.1 %	+1.8 %
Sum of Costs of Maintenance of Analysis Section (10,000 m) Summe Unterhaltungskosten für die Teststrecke (10.000 m)	2,477,876 €	2,994,100 €	2,477,876 €	2,994,100 €	+0.0 %	+0.0 %
Net Bid Sum of Costs for Measures at Analysis Section (10,000 m) Netto Angebotssumme Einzelkosten der Maßnahmen für die Teststrecke (10.000 m)	2,318,255 €	3,226,302 €	3,150,686 €	4,058,732 €	-26.4 %	-20.5 %
Salvage Value of Analysis Section (10,000 m) Restwert der Teststrecke (10.000 m)	3,320,773 €	4,007,072 €	3,320,773 €	4,007,072 €	+0.0 %	+0.0 %
Sum of Road Authority Costs for Analysis Section (10,000 m) Summe Baulastträgerkosten für die Teststrecke (10.000 m)	15,949,404 €	19,644,355 €	16,548,587 €	20,244,027 €	-3.6 %	-3.0 %
User Costs caused by Measures / Maßnahmenbedingte Nutzerkosten	154,213 €	498,065 €	173,790 €	653,596 €	-11.3 %	-23.8 %
Total Costs / Gesamt Kosten	16,103,618 €	20,142,420 €	16,722,377 €	20,897,623 €	-3.7 %	-3.6 %





Conclusion - under theoretic conditions on a virtual road

Road Authority Costs lower

Higher Construction Costs (+2 %)

Clearly lower costs for renewal measures (-27% / 21%)

Socio-Economic Costs lower

Costs caused by extra travel time, fuel consumption, CO₂ emissions and accidents in sum

-11% / -24 %

In total Healroad variants each are more cost-efficient than comparing variants by 4 %



HEALROAD Symposium

ECONOMIC: LOW-COST PREVENTIVE MAINTENANCE TECHNIQUE (Life Cycle Cost Analysis)

Tobias PANWINKLER

Federal Highway Research Institute (BAST)

panwinkler@bast.de

Infravation
An Infrastructure Innovation Programme

