

Onderzoek naar geoptimaliseerde toepassing van vezels in asfalt: het CEDR-FIBRA project

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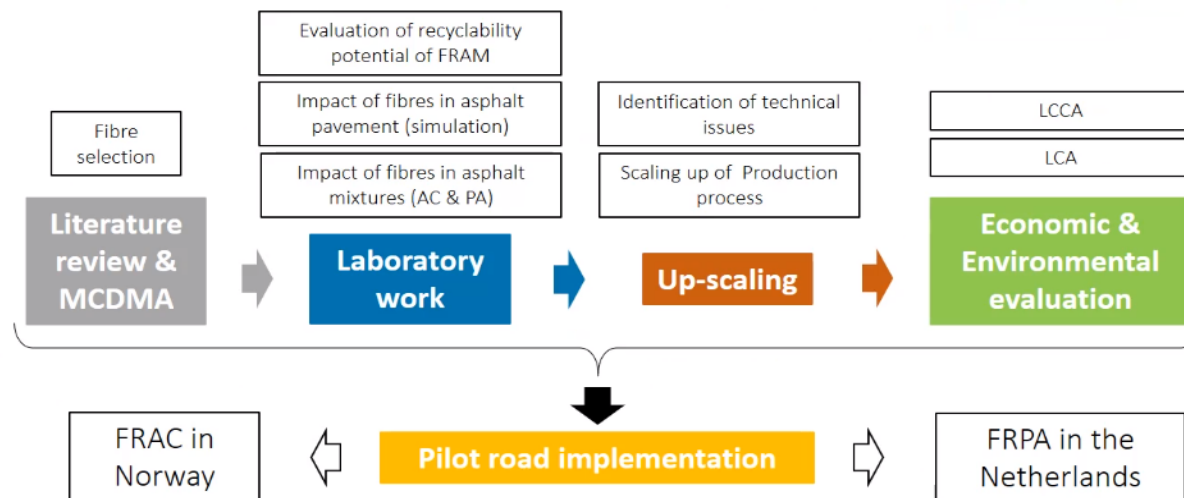
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FIBRA

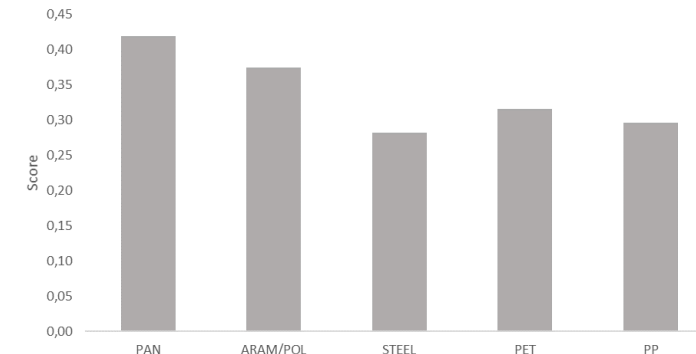
- ✦ Fostering the implementation of fibre-reinforced asphalt mixtures by ensuring its safe, optimized and cost-efficient use



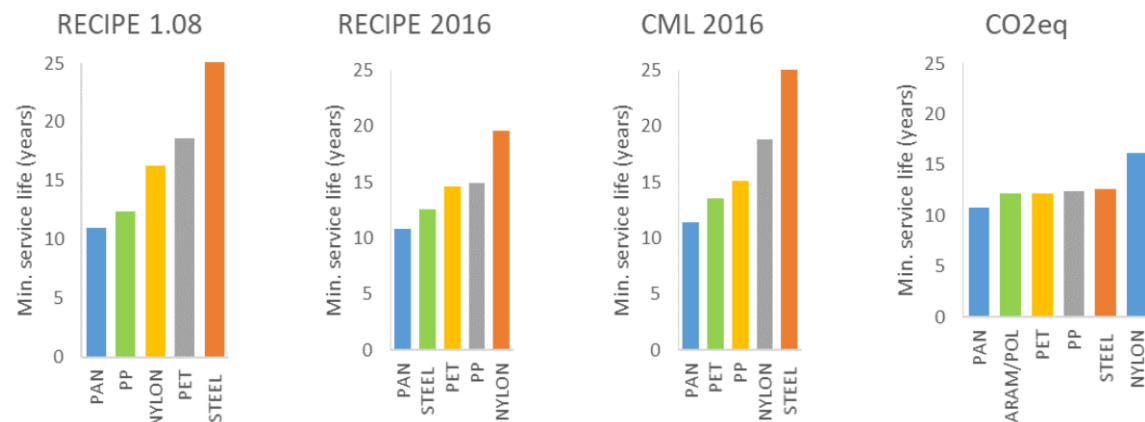
CEDR FIBRA
(2007-2021)

Fibres in asphalt and Multi-criteria decision making assessment (MCDMA)

Fibers	Specific gravity	Tensile strength (MPa)	Length (mm)	Acid/alkali resistance	Decomposition Temp. (°C)	Color	Diameter (μm)
Polyolefin	0.91	>483	19	Inert	130	tan	
Jute	1.45	1450	18		210	brown	16-21
Aramid	1.45	>2750	19	Good	>450	yellow	12
Glass	1.38	1600			850		15-19
Hemp	1.5	1500		Good	380	brown	17-23
Polyacrylonitrile	1.15	>910	4		>240	light yellow	13
Coir Fiber	1.25	1250	50			yellow	18-23
Polyethylene	0.97	400	20	Good	115	white	38
Polyester	1.36	531	6	Good	>249	white	20
Polypropylene	0.9	450	20	Inert	157	white	22
Lignin			1.1		>200		45
Asbestos	2.25	30	5.5	Limited	1400	gray	0.2



Ranking of technical performance of mixtures with fibres: toughness (weighted 30.6%), fatigue life (weighted 25.8%), rutting resistance (weighted 22.9%) and the Indirect Tensile Strength (weighted 17.4%).



Ranking of environmental performance of mixtures with fibres

Quality fibres

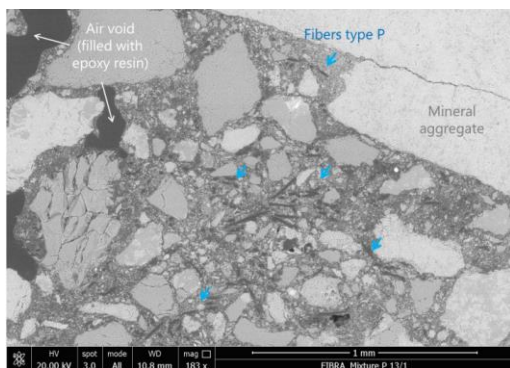
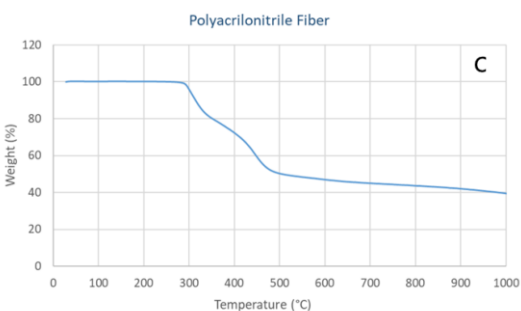
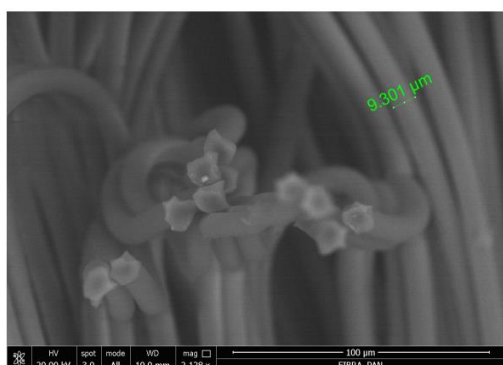
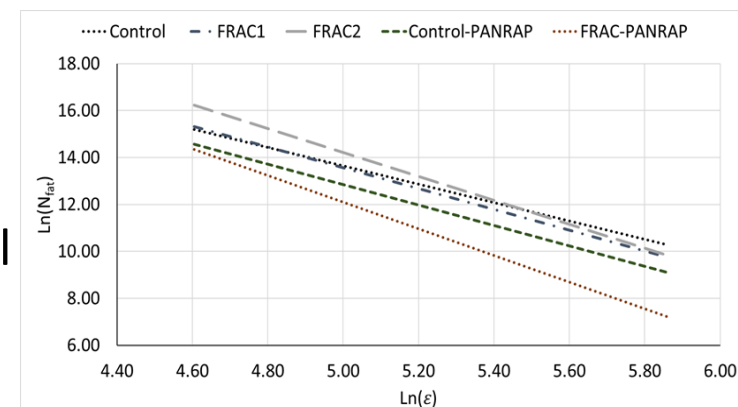
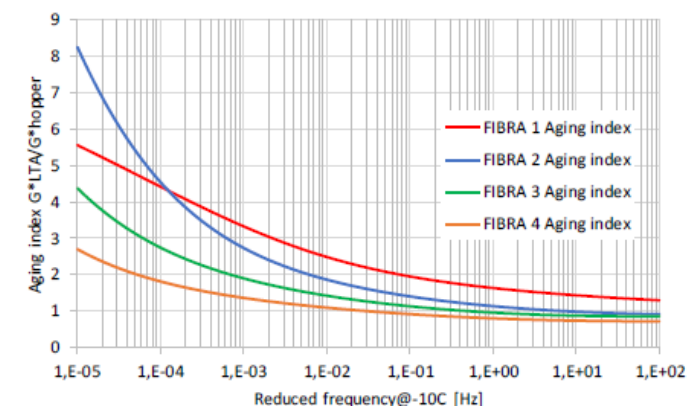
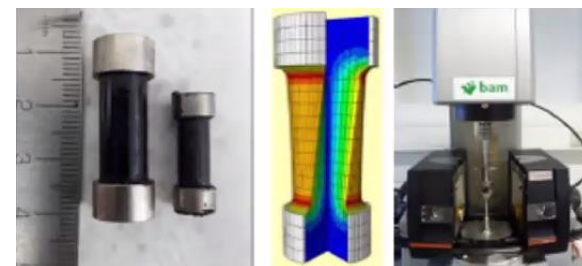
- Indentations and thermal stabilities
- Distributions of fibres in asphalt

Mechanical performance mortar and mixtures (AC, PA)

- **High** stiffness and strength, both mortar and mixture
- **Similar** resistance to rutting compared with PMB, **beter** than pen bitumen
- **Beter** resistance to ageing in mortar
- **Less** resistance to fatigue compared with PMB
- **Lower** ITSr watersensitivity value compared with PMB

Recyclability

- **Recyclable** without complications
- AC mixtures with 50% FIBRA RAP has **similar** mechanical performance than the use of conventional RAP



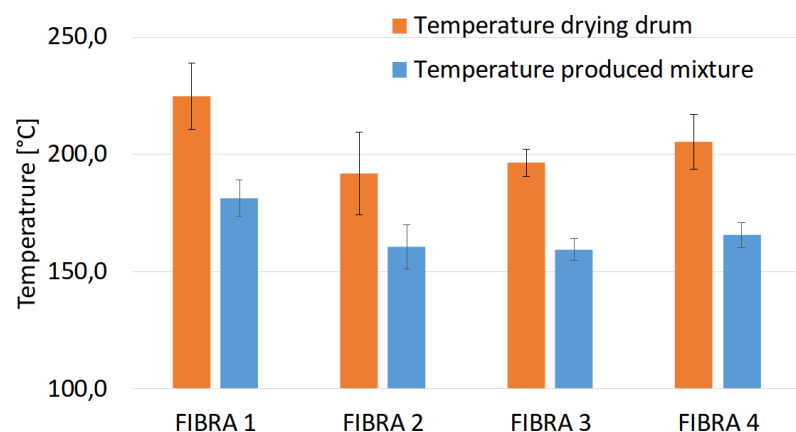
FIBRA PA demonstration sections

- Co-financing of CEDR and Rijkswaterstaat
- A73 motorway near Roermond, 50,000 vehicles per working day
- 4 FIBRA 2L-ZOAB 8 sections, per section about 330 meter
 - FIBRA 1: PMB ref, FIBRA 2: Pen ref, FIBRA 3: PAN, FIBRA 4: Aramid
- Lab, field evaluations and 5-year monitoring

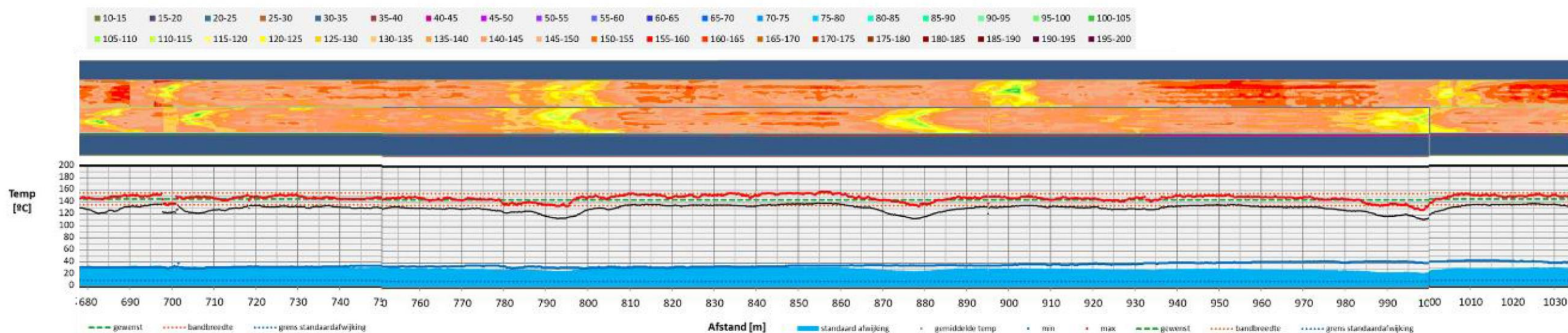


Section	Location	Mixtures	Mixture code	Maximum aggregate size	Bitumen	Fibre or polymer	Production temperature [°C] and method		Reclaimed materials
Fibra 1	Top-layer	2L-ZOAB 8 PMB	Fibra 1/ref	8 mm	PMB	SBS	170-190	std.	0%
Fibra 2	Top-layer	2L-ZOAB 8 Pen	Fibra 2	8 mm	pen		165-170	std.	0%
Fibra 3	Top-layer	2L-ZOAB 8 Panacea	Fibra 3	8 mm	pen	panacea	165-170	std.	0%
Fibra 4	Top-layer	2L-ZOAB 8 Aramid	Fibra 4	8 mm	pen	aramid	165-170	std.	0%
Fibra 1-4	Under-layer	2L-ZOAB 16 30% PR	OL ref	16 mm	pen		165-170	std.	30%

Realisation of FIBRA sections

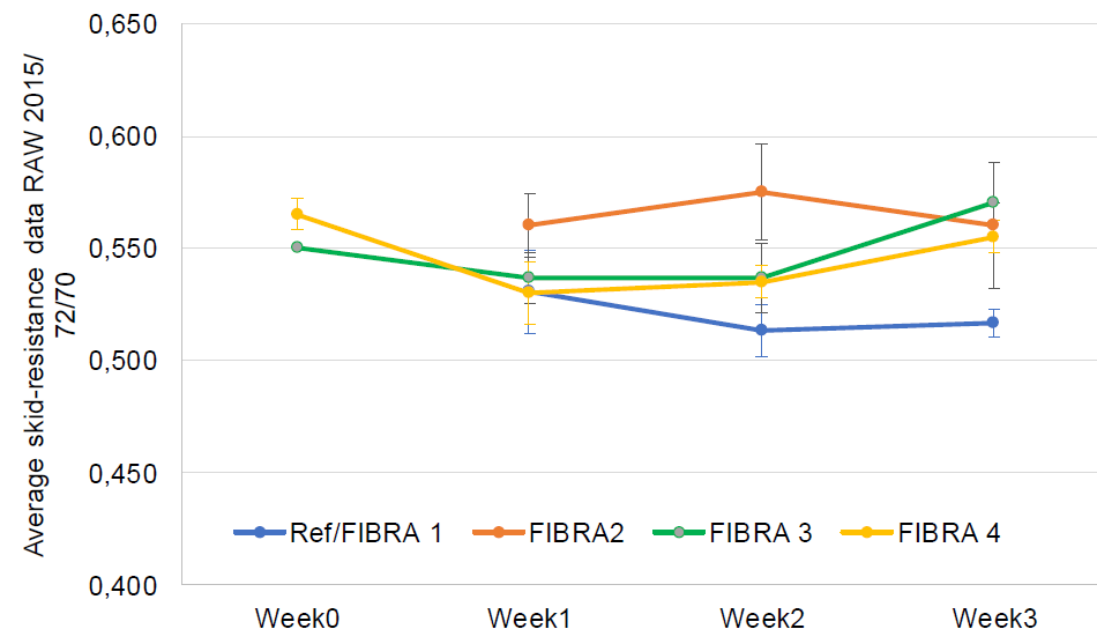
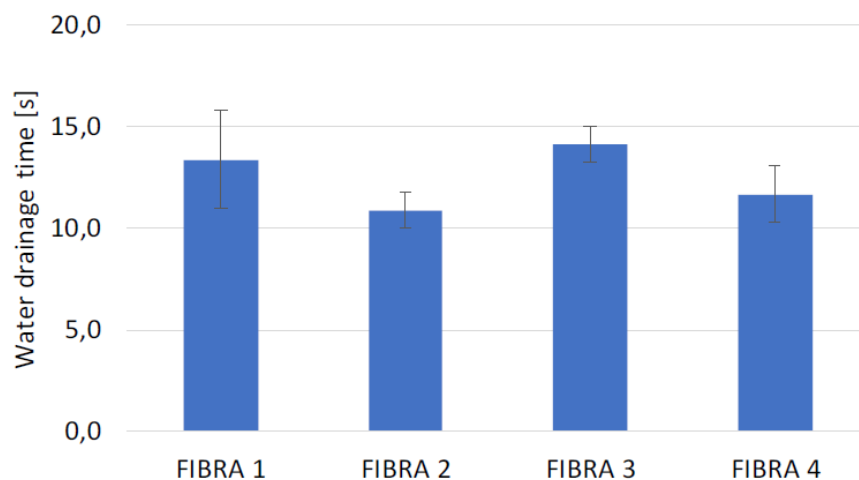


Section	Analyse	Paver 1	Paver 2
FIBRA 1	Average Temperature	156.20 °C	156.88 °C
	Standard deviation	8.98 °C	11.12 °C
FIBRA 2	Average Temperature	145.02 °C	135.89 °C
	Standard deviation	11.32 °C	8.14 °C
FIBRA 3	Average Temperature	144.43 °C	139.60 °C
	Standard deviation	8.00 °C	8.32 °C
FIBRA 4	Average Temperature	149.25 °C	146.32 °C
	Standard deviation	10.08 °C	6.72 °C



Field evaluation of A73

- Drainage capacity, noise-reducing performance, longitudinal evenness are **not affected** by the addition of fibres
- Skid-resistance results shows that FIBRA mixtures are **faster** in wearing-off of the mortar films.
- Visual inspection **3 month**, 2 and 5 years



Section	CPXP [dB(A)] for light vehicles		CPXH [dB(A)] for heavy vehicles	
	Left lane lane 1	Right lane lane 2	Left lane lane 1	Right lane lane 2
FIBRA 1	91.3 (0.5)	92.8 (0.3)	92.5(0.8)	92.5 (0.1)
FIBRA 2	91.6 (0.4)	92.9 (0.5)	91.9 (0.1)	92.4 (0.2)
FIBRA 3	91.4 (0.4)	92.4 (0.4)	91.9 (0.3)	92.4 (0.2)
FIBRA 4	91.3 (0.2)	92.5 (0.3)	91.7 (0.2)	92.3 (0.1)

Accelerated pavement test

- Cooperation with CEDR Pavement LCM project,
- Circular Road Simulator (CRS): Diameter 5.25 m, 6 wheels, speed up to 70 km/h
- Three aging conditions:
 - ❑ virgin, oven aging 1 week and 2 weeks at 86°C
- Three loading phases
 - ❑ Phase 1. 60k laps at 35 °C in dry conditions.
 - ❑ Phase 2. 120k laps at about 0 °C under seven freeze-thaw cycles in wet conditions.
 - ❑ Phase 3. 2k laps at 30 °C in dry conditions with a soft base.

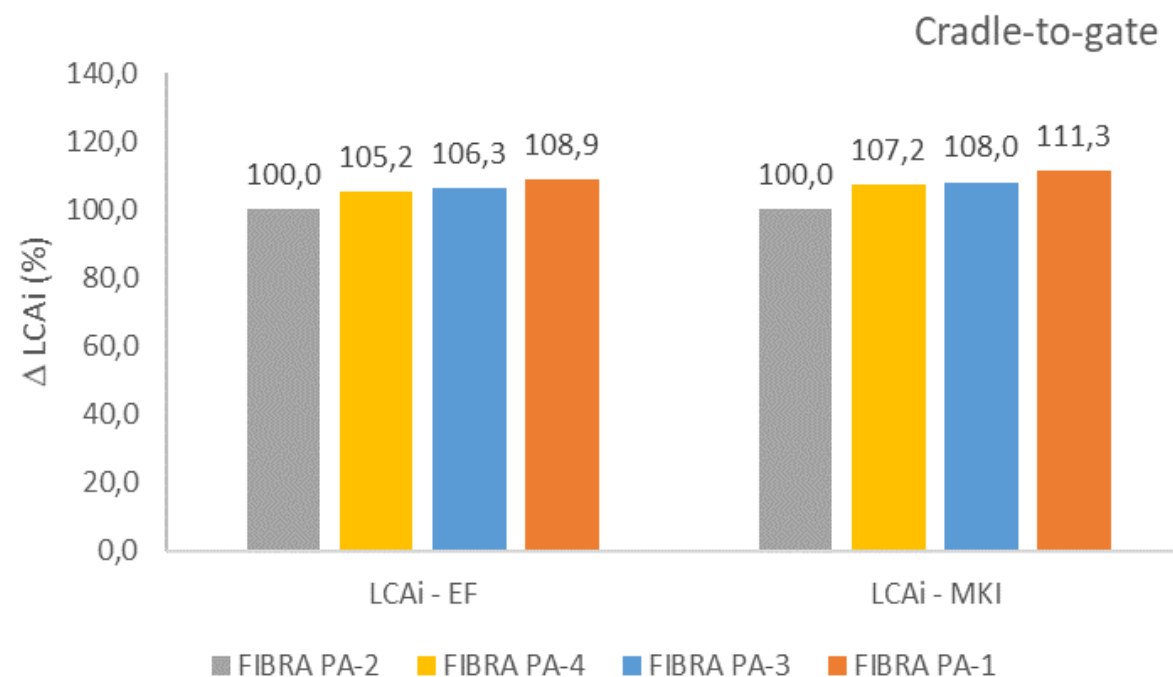
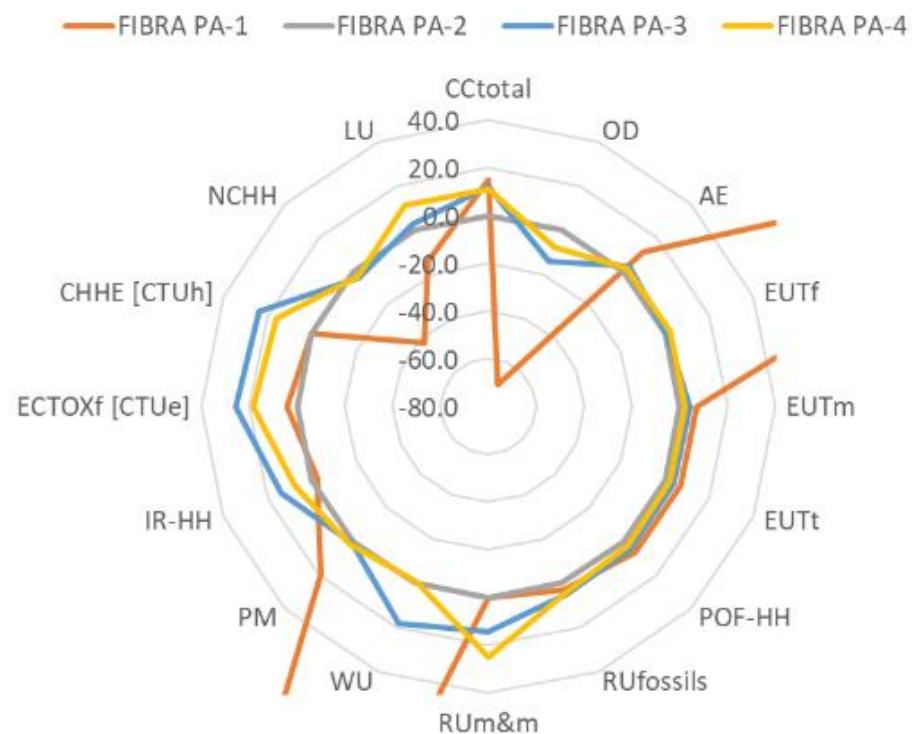
The relative performance is indicated with -, =, +, ++ where - and - indicates much worse and worse, = indicates equal performance and + and ++ indicates better or much better performance.

	Test	Fibra 1 / PA8	Fibra 3 / PA8 panacea	Fibra 4 / PA8 aramid
Traffic/virgin	ALT / CRS	+ ravelling + rutting + cracking + friction	= ravelling = rutting = cracking + friction	= ravelling = rutting = cracking + friction
Traffic/aging	ALT / CRS aged material	- - ravelling + rutting = cracking + friction	- - ravelling + rutting = cracking + friction	- - ravelling + rutting = cracking + friction
Traffic/climate	ALT / CRS Water sensitivity and freeze-thaw cycles	=	=	=



Table 7-5. Estimated lifetimes for PA mixes on high-volume roads in years.

Country\Mix	PA16 (ZOAB+)	PA8 (Fibra 1)	PA8 panacea (Fibra 3)	PA8 aramid (Fibra 4)
Sweden, Netherlands and Germany	12	11	10	10



Cradle-to-gate analysis: FIBRA2 (pen bitumen) assigned as 100%

Conclusions and recommendations

Conclusions

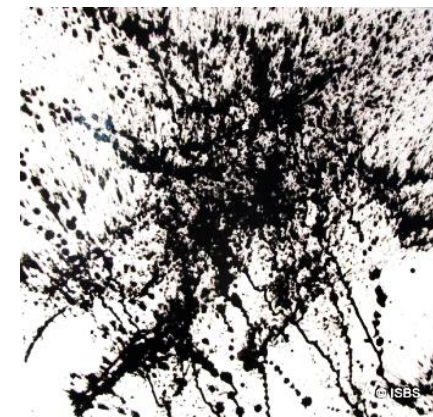
- Fibre-reinforcement can be successfully **designed and applied** for both AC and PA mixes. The **laboratory and field** evaluation results indicate that FIBRA mixtures and test sections have **good performance**. It is expected that aged FRAM mixes **can be recycled** in a similar way than conventional RAP.
- The accelerated load testing CRS concludes that our FIBRA mixtures without addition of PMB but pen bitumen with fibres have a **service life similar** to that of the reference mixture with PMB.
- The LCA analysis shows that the use of fibre reinforcement results in **less environmental impact** than the use of PMB in asphalt mixtures.

Recommendations

- **Optimalisation** fibre type, aspect ratio and application rate
- **Long term monitoring** and portfolio of test sections (e.g. A50 FIBRA sections 2021)
- RWS werkgroep **Vezels in asfalt**: validation in the lab/field/environmental aspects

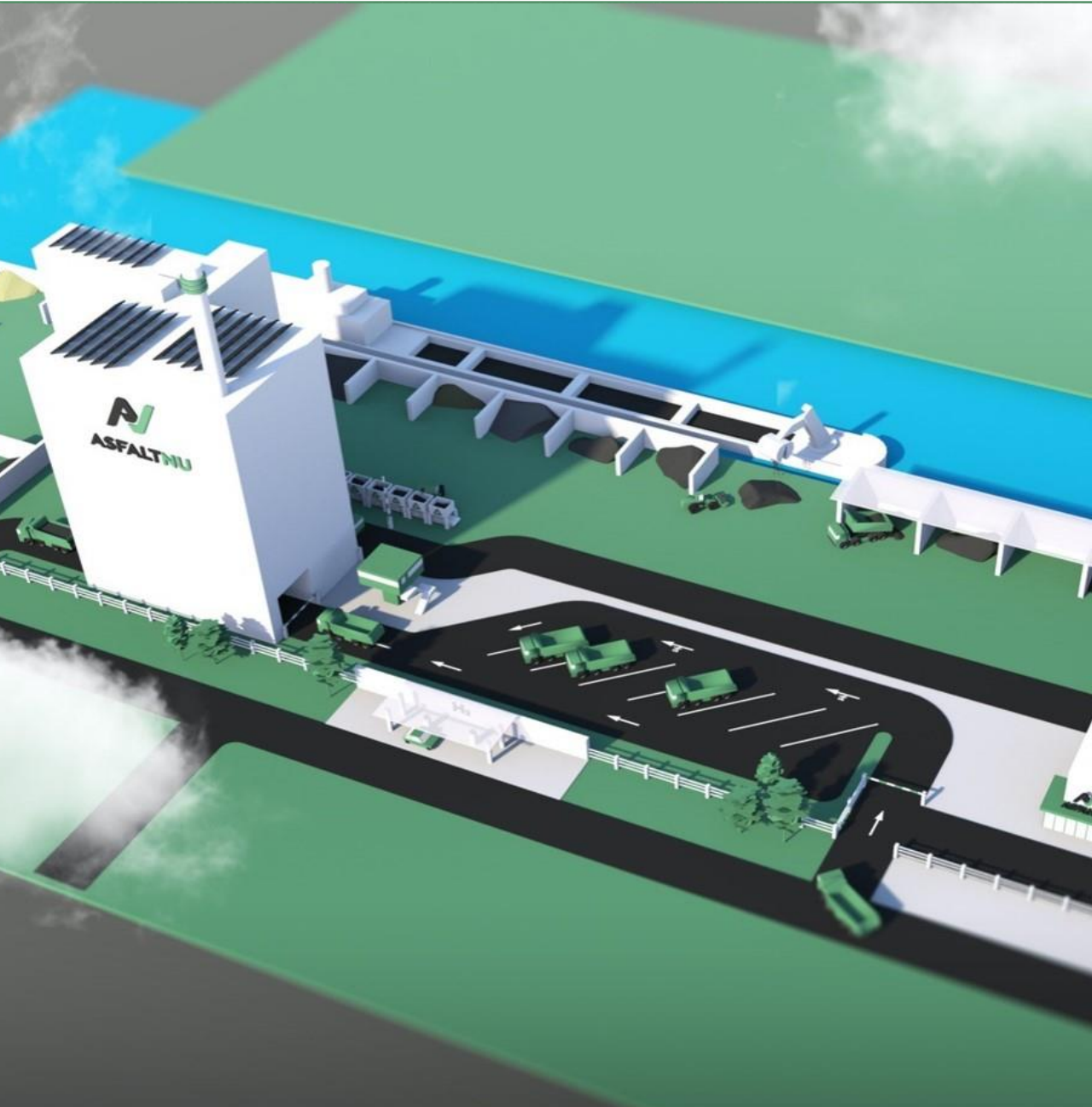


Vezels en Polymeren vormen beide een wapeningsnet in de mastiek. Hieruit volgt dat de werking van vezels vergelijkbaar kan zijn met die van polymeren.



In opendeklagen verlengen vezels en PMB's de levensduur op dezelfde manier door veroudering te beperken.





Thanks for your
attention,
Questions?

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