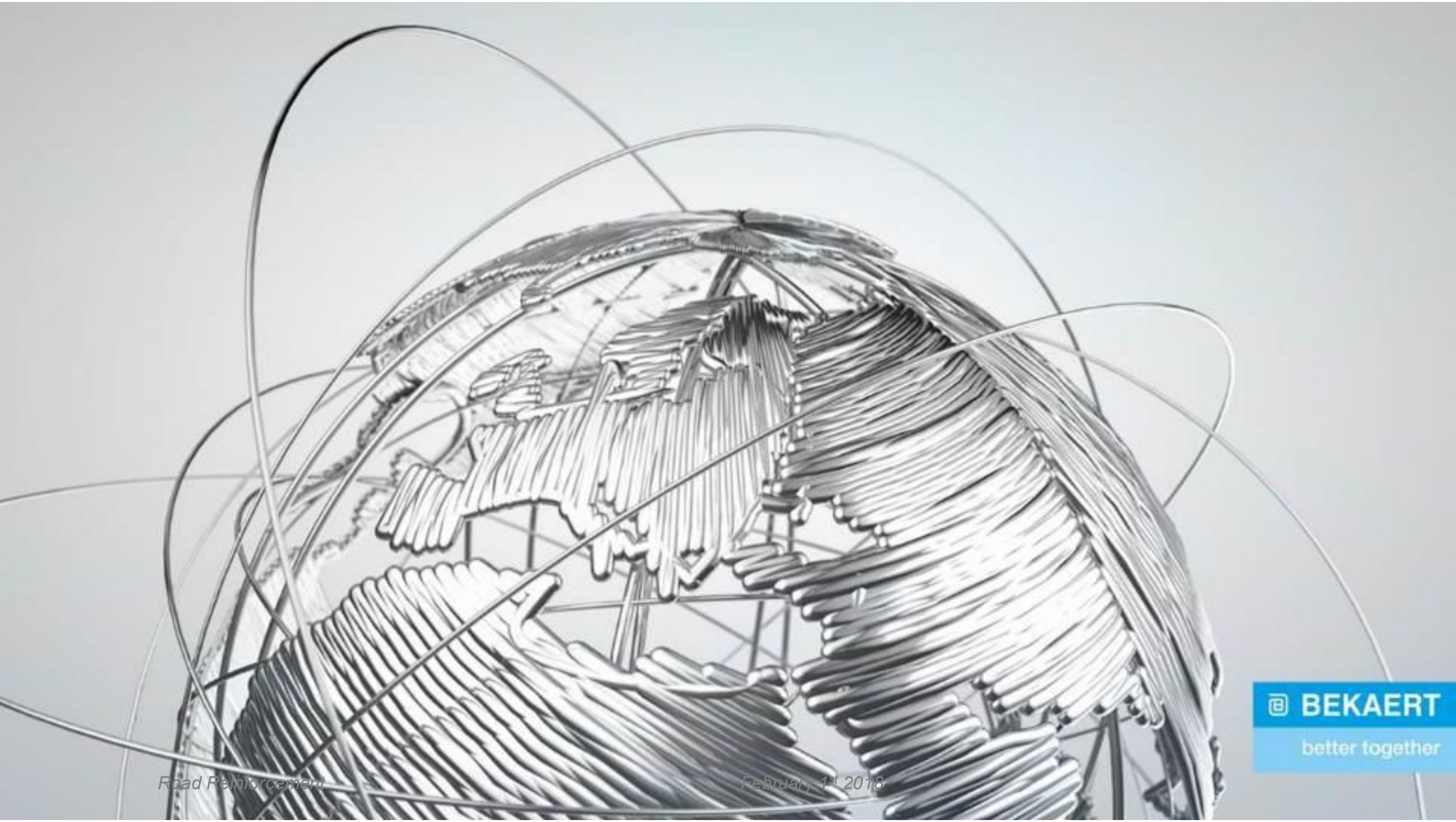

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Performance testing anti-cracking interlayers

Frederik Vervaecke

Zwevegem

February 2018

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Laboratory testing

Standardized testing of anti-cracking interlayers for asphalt:

Properties interlayer

Tensile testing

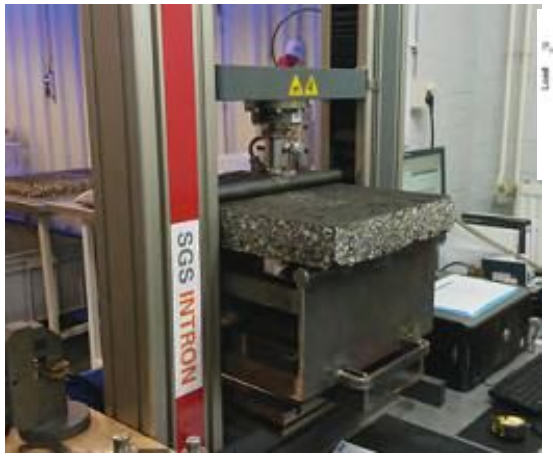
Bitumen retention test

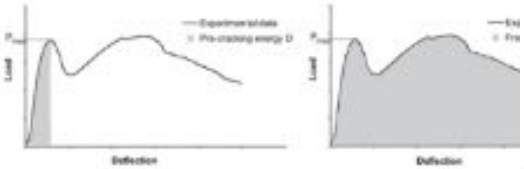
Performance anti-cracking interlayer

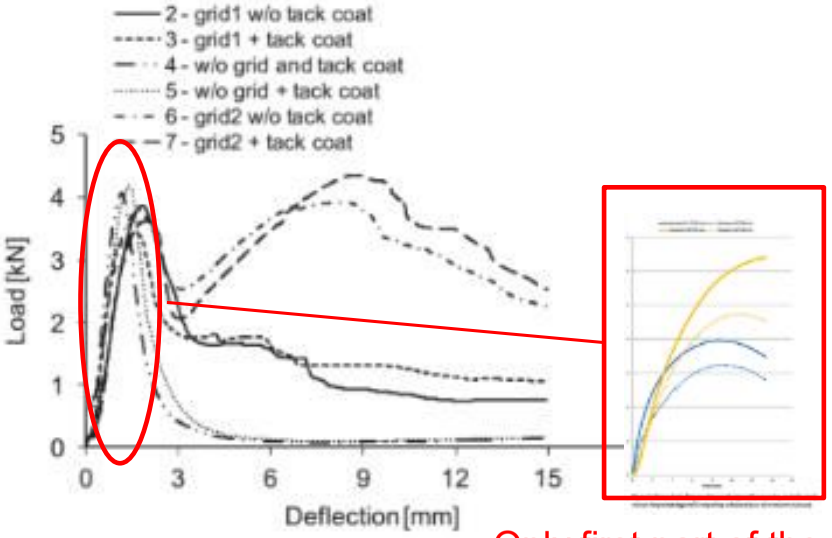
Nothing standardized

Big variaty of performance tests of anti-cracking interlayers:

1. Static testing : 3- or 4-pt bending test:







Only first part of the curve was recorded & investigated

Pro:
- fast test;
- Simple setup;
- Relative large samples;

Contra:
- Relavant for reality?
- Not straight forward interpretation;

A.G. Kneepkens, M Verweij, 2015, "Gewapende feiten over asfaltwapening", Civielm techniek Nr , 30-33
E. Pasquini, M. Bocci, G. Ferrotti, & F. Canestrari, éà&", "Laboratory characterisation and field validation of geogrid-reinforced asphalt pavements", Road Mat. & Pav. Design, 14:1, 17-35.

Big variaty of performance tests of anti-cracking interlayers:

2. Cyclic bending tests:

   Several setups and research groups have there own test (Nottingham, Santander, Teheran, Italy,…)

D.Z. Zamora-Barraza, MA. Calzada-Pérez, D. Castro-Fresno, A. Vega-Zamanillo, 2011, *"Evaluation of anti-reflective cracking systems using geosynthetics in the interlayer zone, Geotextiles & geomembranes 29, 130-136.*

J. Norambuena-Contreras,& I Gonzalez-Torre, 2015, "*Influence of geosynthetic type on retarding cracking in asphalt pavements",* Construction & Building Materials 78, 412-429.

I. Gonzalez-Torre, M Calzada-Perez, A. Vega-Zamanillo, D. Castro-Fresno, 2015, *"Evaluation of reflective cracking in pavements using a new procedure that combine loads with different frequencies*", Construction & Building Materials 75, 368-374.

G. Ferrotti, F. Canestrari, A. Virgili, A. Grilli, "*A strategic laboratory approach for the performance investigation of geogrids in flexible pavements*," Construction and Building Materials 25 (2011) 2343-2348

A.Virgili, F. Canestrari, A. Grilli, F.A. Santagata, "*Repeated load test on bituminous systems reinforced by geosynthetics*", Geotextiles and Geomembranes 27 (2009) 187-195

S. Fallah & A. Khodaii, 2015, *"Reinforcing ocverlay to reduce reflection cracking; an experimental* investigation", Geotextiles & Geomembranes 43, 216-227.

Brown, *"An assessment of geogrid use in railways and asphalt applications"*, Jubilee 2009.

Brown, Brunton, Hughes & Bodrick, 1985, "*Polymer grid reinforcement of asphalt",* Journal as Asphalt Technology, 54, 18-41.

Brown Thom, & Sanders, 2001, *"A study of grid reinforced asphalt to combat reflection cracking",* Journal of Asphalt Paving Technology; 70, 543-570.

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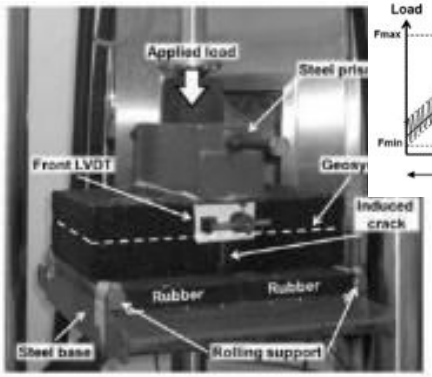
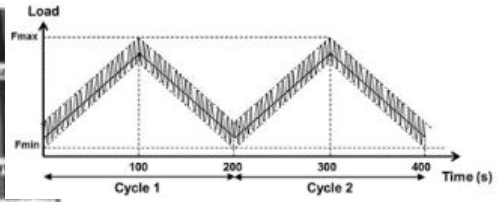
Big variaty of performance tests of anti-cracking interlayers:

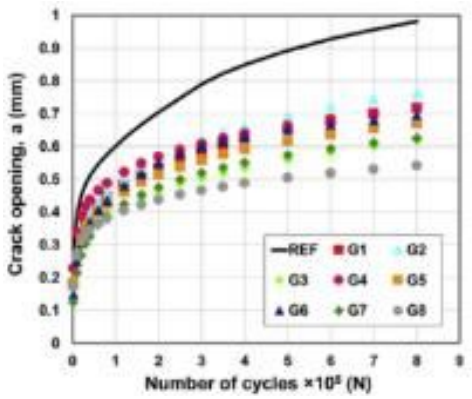
2. Cyclic bending tests:

Several setups and research groups have there own test (Nottingham, Santander, Teheran, Italy,…)

Example:







Pro:

- Relative simple test setup;
- Relative large samples;

Contra:

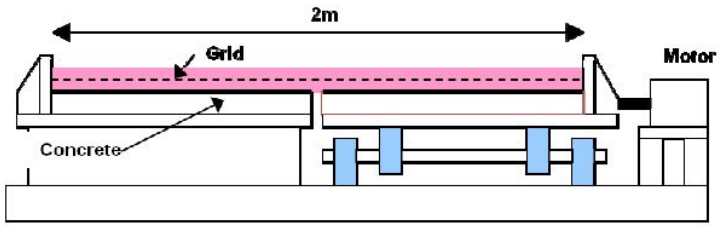
- Long test
- Spread on results (fatigue)
- Not straight forward interpretation

Big variaty of performance tests of anti-cracking interlayers:

3. Thermal movement test:

Several setups and research groups have there own test (Nottingham, Texas, Belgium, ...)

Example:



Contra:

- Long test
- Spread on results (fatigue)
- Special setup is needed

Pro:

- Realistic seasonal movement;
- Relative large samples are possible;

J. Li, J. Oh, B Naik, G.S. Simate, L.F. Walabitu, "*Laboratory characterization of cracking-resistance potential of asphalt mixes using overlay tester",* Con. & Build, mat. 70 (2014), 130-140;
L.F. Walubita, A.N.M. Faruk, J. Zhang, X. Hu, "*Charaterizing the cracking & fracture properties of geosyntehtic interlayer reinforced HMA samples using the Overlay Tester (OT)",* Con. & Build, mat. 93 (2015), 695-702;
F. Zhou, S. Hu, D. Chen, T. Scullion, "*Overlay tester: A simple performance test for fatigue cracking*", TRB 2007 Annual Meeting
R. Lytton, "*Use of geotextiles for reinforcement and strain belief in asphalt concrete",* Geotextiles and Geomembranes 8 (1989) 217-237

Big variaty of performance tests of anti-cracking interlayers:

4. Large scale fatigue testing:

Several setups and research groups have there own test (France, Spain, Switserland,Netherlands, ...)

Example:

Contra:

- Long test
- Spread on results (fatigue)
- Special setup is needed
- Complete road structure not only the asphalt/interlayer composite
- Very expensive

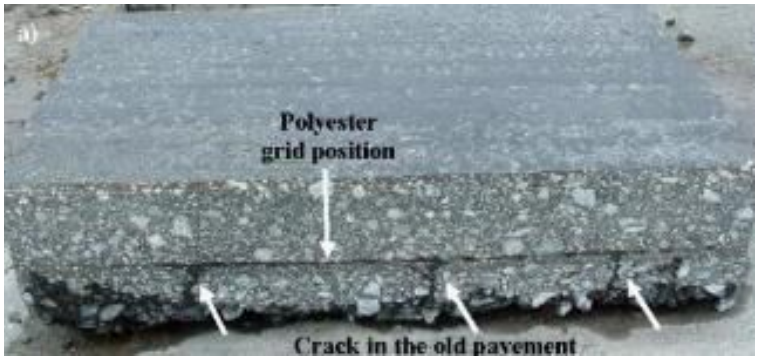
Pro:

- Realistic situation
- Entire road structure

https://www.hbm.com/en/5949/cedex-test-track-accelerated-pavement-testing/

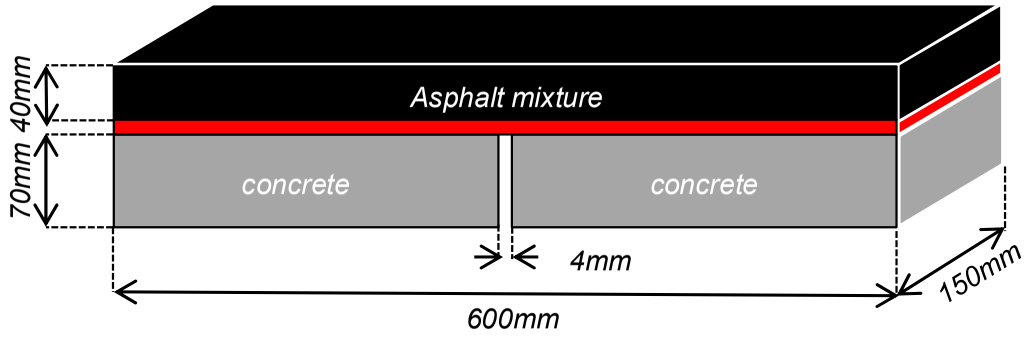
Important parameters for testing anti-cracking interlayers:

- *Testing the composite (interlayer, tack coat & asphalt) as it is used in the application;*
- *As reflective cracking is a fatigue behavior, it is important to perform cyclic testing;*



- *Sample dimensions must be adapted to the dimensions of the anti-cracking interlayer;*
- *Details of asphalt, tack coat, base layer need to be kept unchanged;*

Thermal plate test :

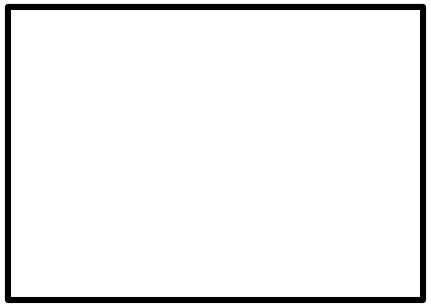
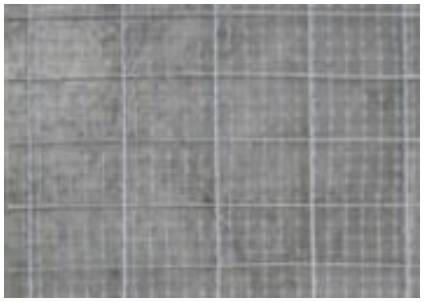
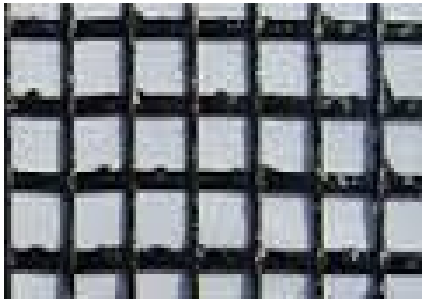


Interlayer system:
reinforcement + bitumen layer

- ⇨ specimen on bed of steel balls for free horizontal displacement;
- ⇨ climate chamber conditioned at -10°C;
- ⇨ slow cyclic opening & closing joint (1mm) by contraction & expansion of loading frame;
- ⇨ Observations:
  - *crack initiation & development (by pictures);*
  - *applied force;*
  - *opening joint (0-1mm);*
  - *relative displacement in overlay (2cm above joint).*

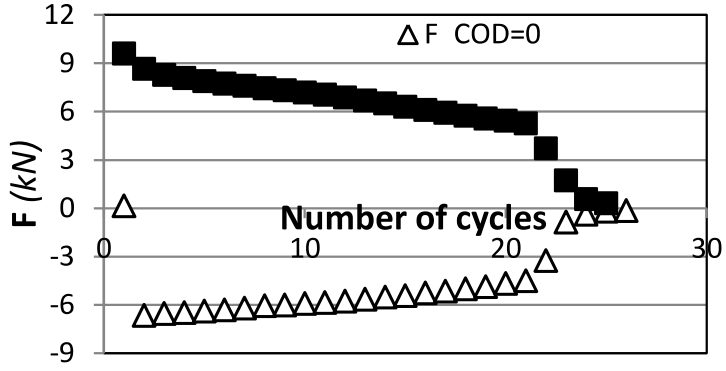
** Operating procedure for thermal cracking test, Belgian Road Research Centre, oct 2010.*

Thermal plate test :

reference - no interlayer	Fortifix® 1-O	Glas grid 35x35
		
+ 300g/m² tack coat	(38x50)kN/m (3100x4400)kN/m + 300g/m² tack coat	(70x100)kN/m (2800x4000)kN/m + 300g/m² tack coat

** All tests were done in the same period to make sure there are no differences in used materials.*

Thermal plate test :



	F_{max} (kN)	Crack initiation		End of test		Remarks
		cycles	time (h)	cycles	time (h)	
Reference	8	1	2	5	10	*crack*
Fortifix	9	Na	Na	Na	130	*no cracks*
	8,7	35	126	35	126	*delamination*
	9,5	15	42	24	90	*crack*
Glas grid	9,6	8	32	11	48	*delamination + crack*
	9,3	28	108	28	108	*delamination*

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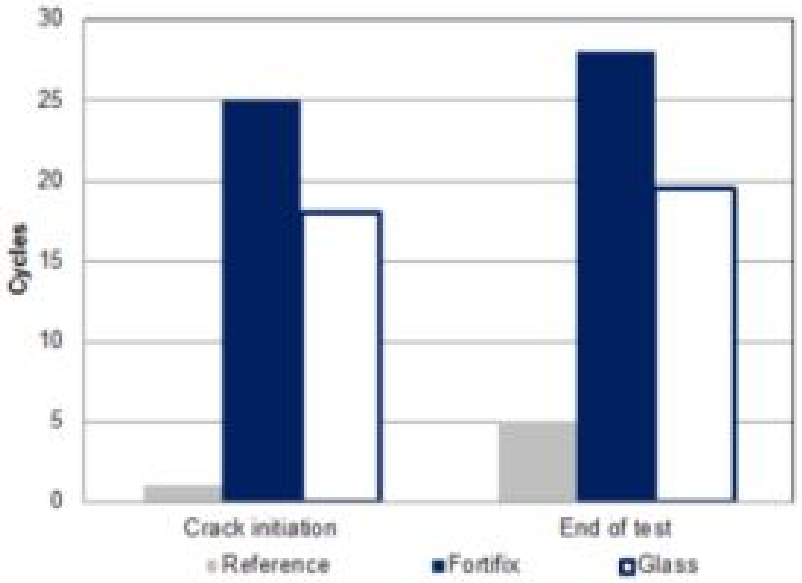
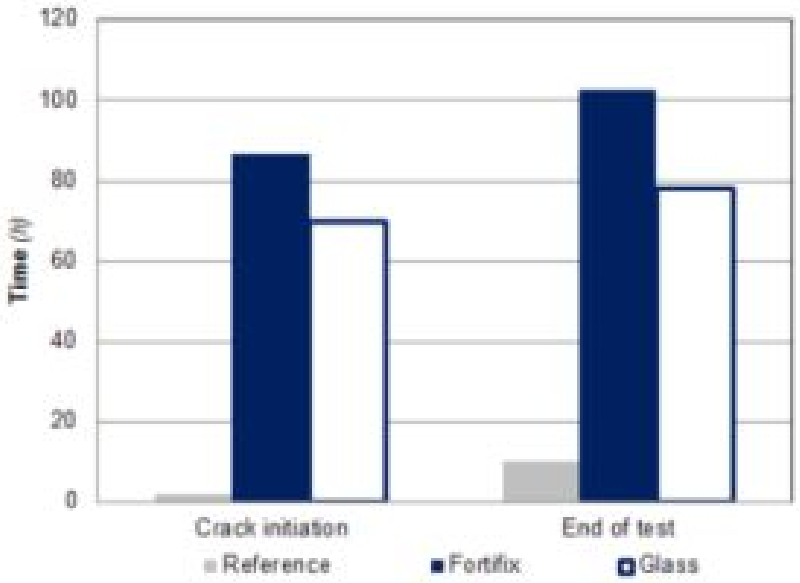
Thermal plate test :





strength new steel grid = ½ x glas grid & EA is equal

⇨ ***similar/better performance*** *(15-50%)*

Preliminary & unpublished results

What about FF1 & carbophalt?

• *Reference*	*no interlayer*	*tackcoat*	*300g/m²*	
• *SAMI*	*SAMI*	*PMB*	*2kg/m²*	
• *Carbon/glas grid*	*(120x200)kN/m*	*tackcoat*	*300g/m²*	
	(4 000x12 000)kN/m			
• *FF1-C*	*(42x54)kN/m*	*tackcoat*	*500g/m²*	*(1 sample)*
	(3 000x4 400)kN/m		*700g/m²*	*(2 samples)*

To be submitted for publication in 2019

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Preliminary & unpublished results

What about FF1 & carbophalt?

	Tack coat	F_{max}	Crack initiation	Crack @ top asphalt	F_{end}	Remarks
	g/m²	(kN)	cycles	cycles	(kN)	
Reference	300	8	1	5	0,04	crack
SAMI	2000	7	1	2	0,04	cracks
	2000	9	1	3	0,08	delamination + crack
Carbon/glas	300	10,5	2	5	2,6	delamination + crack
	300	10	1	5	4,2	crack
FF1-C	500	11,4	2	30	3,7	crack
	700	11,9	1	20	2,8	crack
	700	12	10	50	5,5	crack (not @surface yet)

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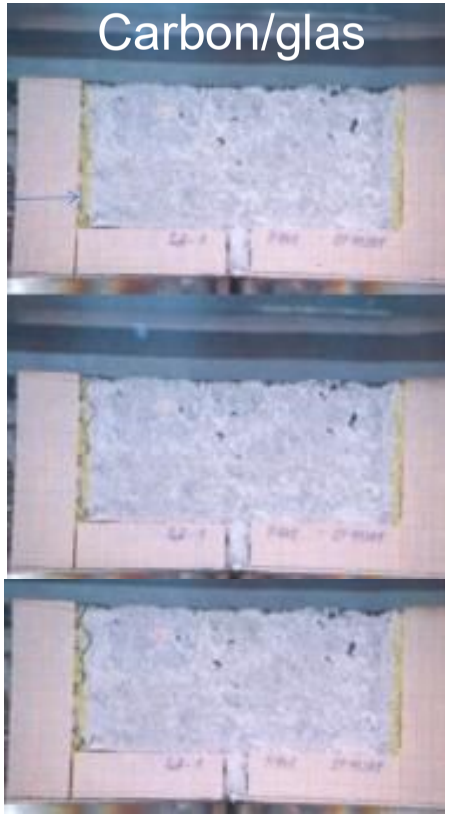
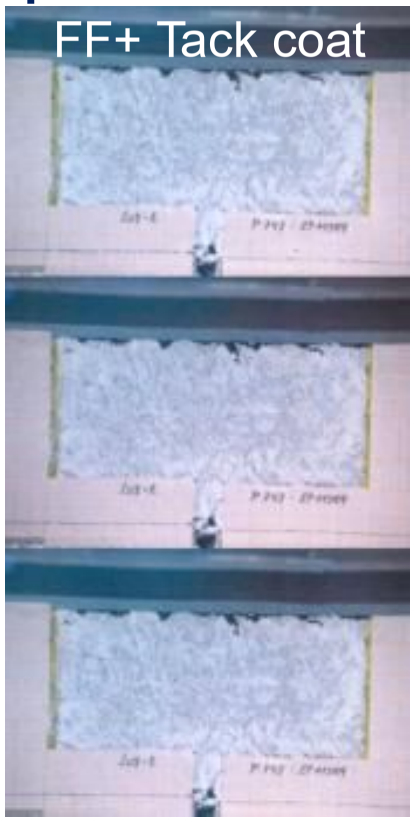
Preliminary & unpublished results

What about FF1 & carbophalt?





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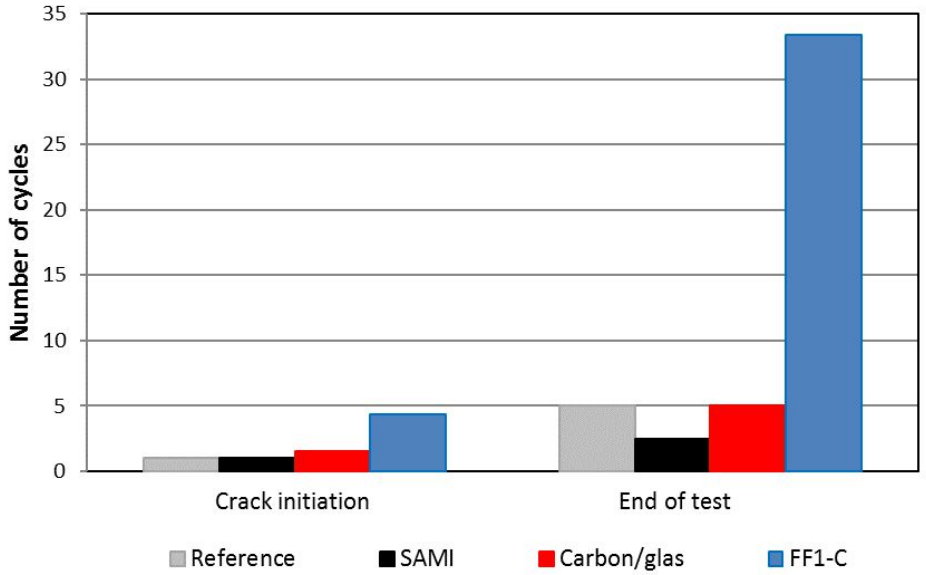
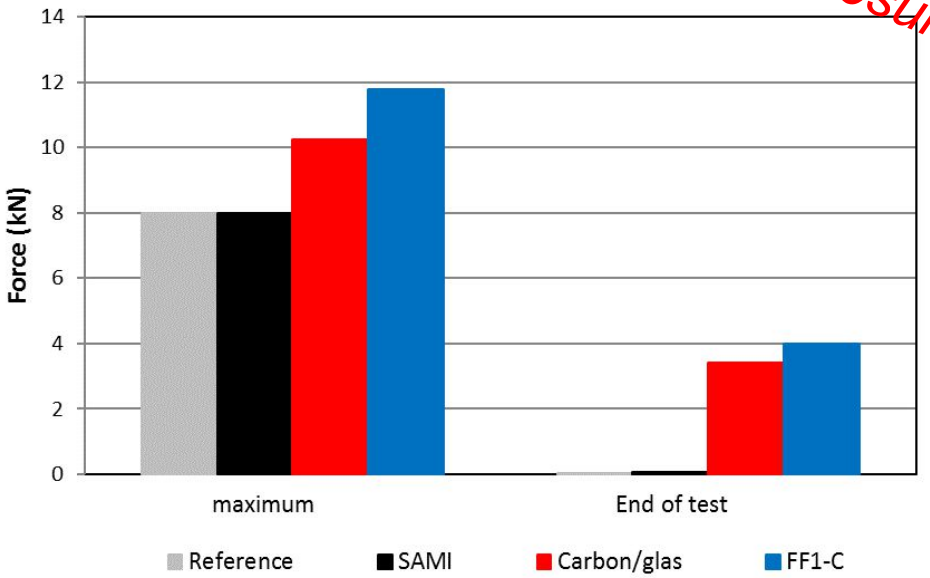
Preliminary & unpublished results

What about FF1 & carbophalt?





⇨ Both the number of cycles before the end of the test as the maximum force & the force ot the end of the test show a significant effect on preventing crack initiation and crack growth.

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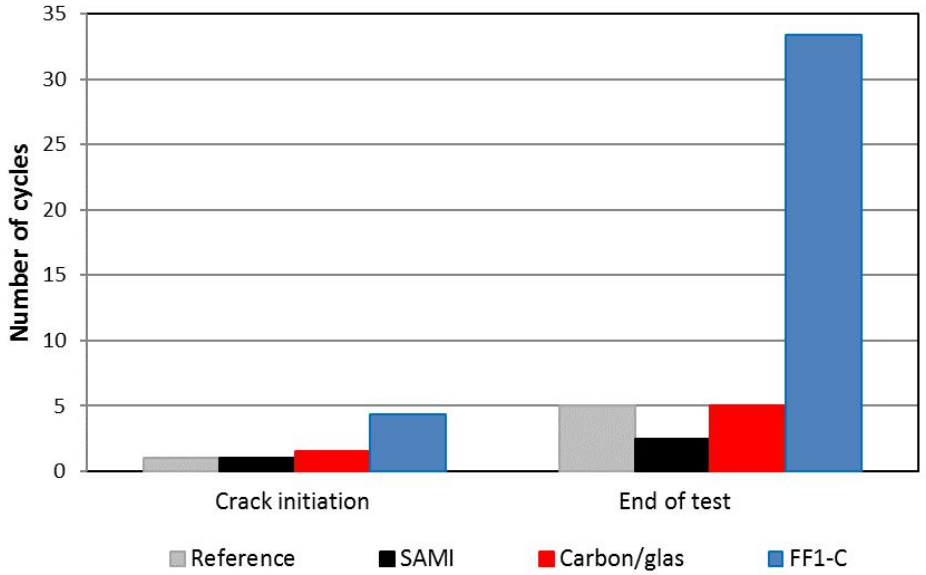
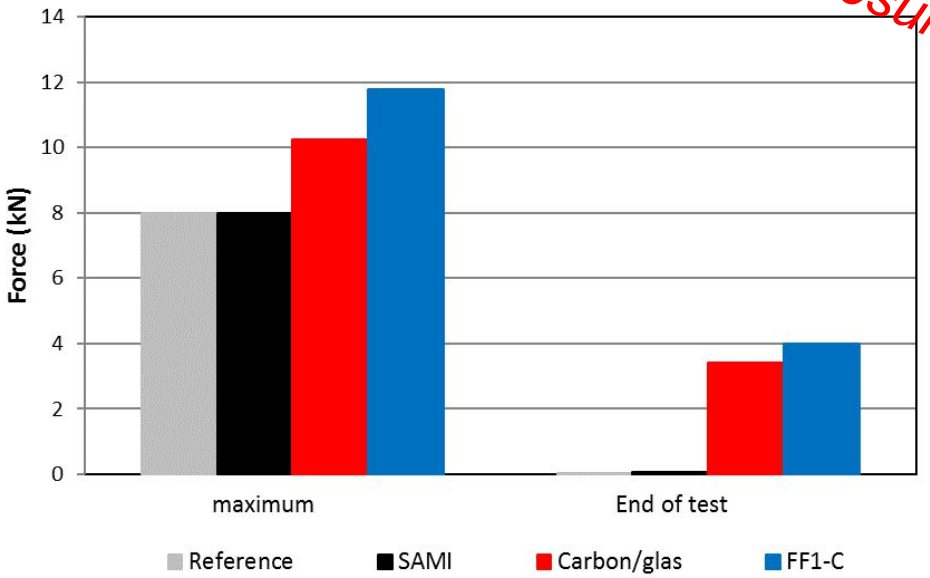
Preliminary & unpublished results

What about FF1 & carbophalt?





Athough FF = 1/4 x carbon grid & EA FF = 1/3 x carbon grid

⇨ ***better performance based on crack propagation & Force take-up***

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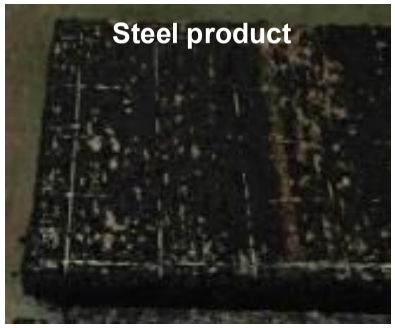
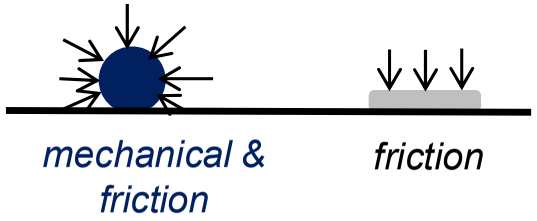
Preliminary & unpublished results

How can this be explained?

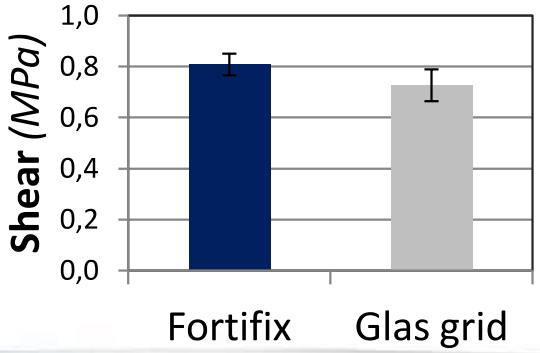
1. Adhesion to overlay :



Interlocking 3D structure ensures anchorage;



2. Adhesion existing surface & overlay:



Shear test:

limited reduction surface by steel compared to glass

⇨ *adhesion interface is less influenced*

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Road Reinforcement

February 1st 2018