



PPRS NICE 2018 • MARCH 26-28

PAVEMENT PRESERVATION & RECYCLING SUMMIT

HEALROAD Symposium

HEALROAD laboratory research

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Infravation
An Infrastructure Innovation Programme





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PAVEMENT PRESERVATION & RECYCLING SUMMIT

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HEALROAD POROUS ASPHALT

1. MECHANICAL PERFORMANCE



2. HEALING ASSESSMENT



3. RECYCLABILITY



4. CONCLUSIONS





1. MECHANICAL PERFORMANCE

Materials



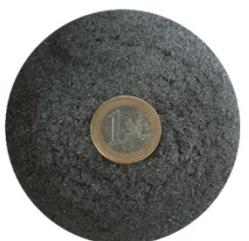
Aggregates

Coarse: Ophitic (porphyric)
Fine & Filler: Limestone



Bitumen

Conventional 50/70
penetration grade

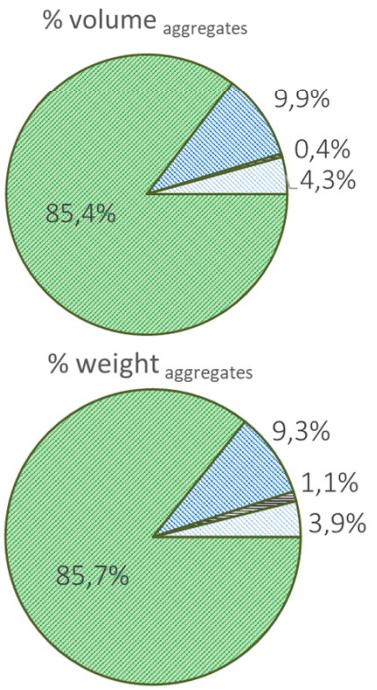
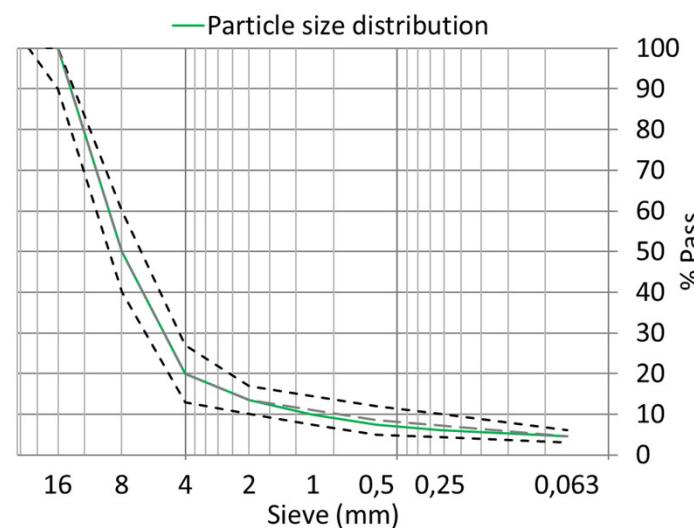


Metallic particles

Steel wool
Length < 4 mm
Diameter < 0.6 mm

Dosage

0.3 % of metallic particles by volume of mixture



■ Coarse aggregate ■ Fine aggregate
■ Metallic fibres ■ Filler



1. MECHANICAL PERFORMANCE

Mechanical tests

Voids test (EN 12697 – 8)

Bitumen /mixture (%)	4.5
Density (g/cm ³)	2.121
Voids in mixture (%)	20.8

Cantabro loss particle test Dry (EN 12697 – 17) & Wet (NLT – 362)

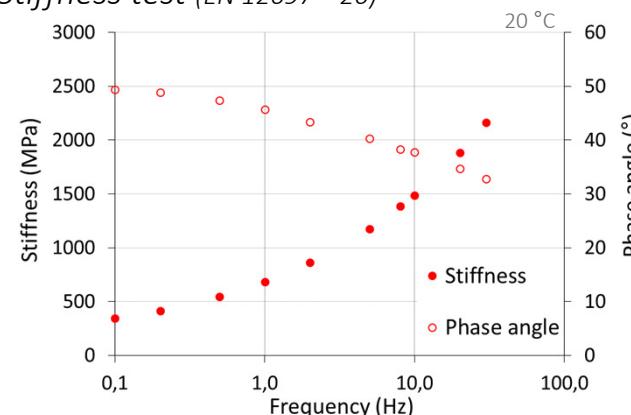
	Dry	Wet
Loss particle (%)	20.9	23.2

Water sensitivity test (EN 12697 – 12)

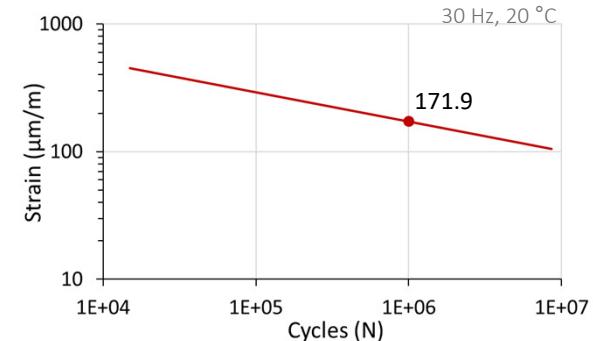
	Dry	Wet
I.T.S. (KPa)	1319.8	1125.9
I.T.S.R. (%)	85	

Dynamic tests

Stiffness test (EN 12697 – 26)



Fatigue resistance test (EN 12697 – 24)

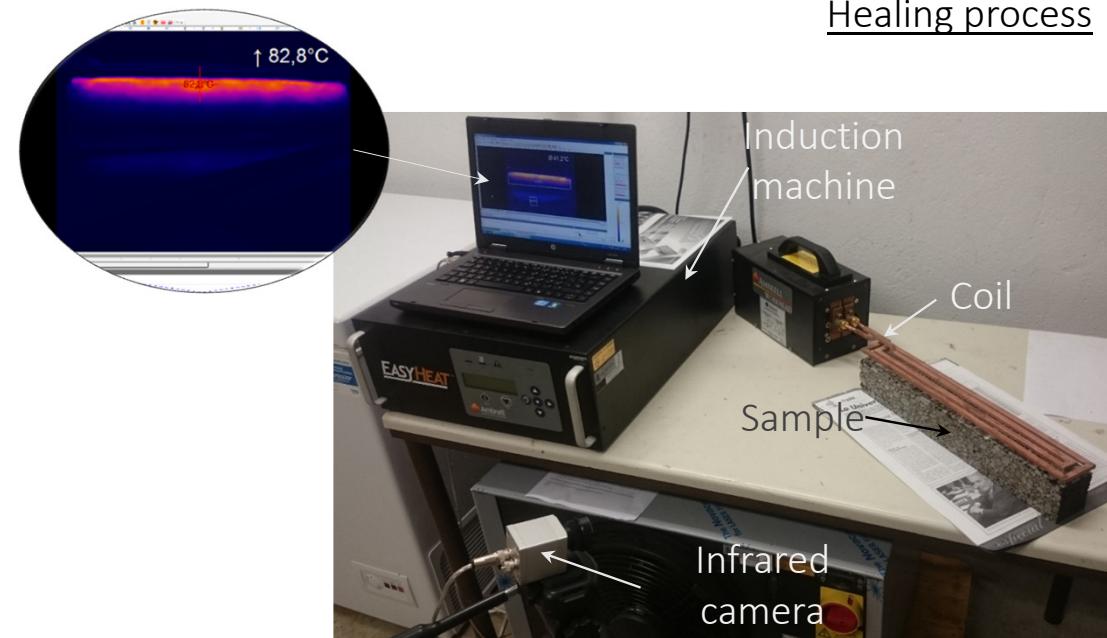
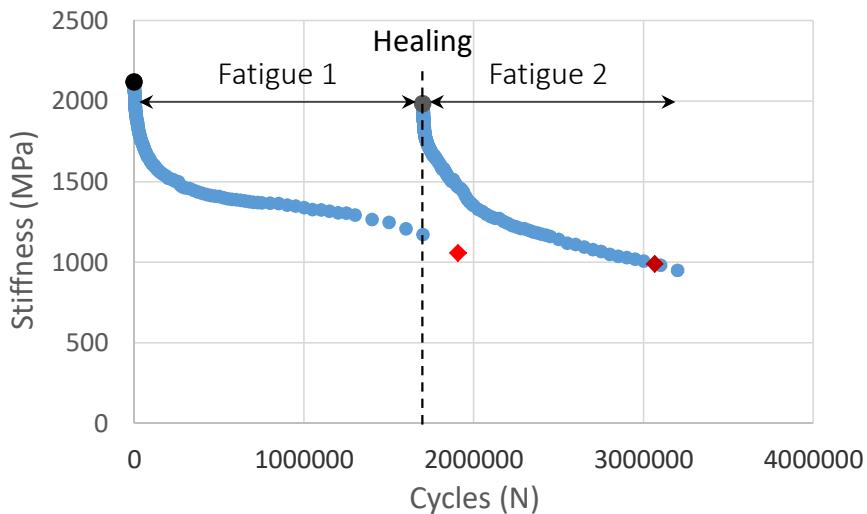




2. HEALING ASSESSMENT

Procedure

4 point bending test



$$\text{Healing Ratio} = \frac{\text{Cycles 1} + (\text{healing}) + \text{Cycles 2}}{\text{Cycles of failure}}$$

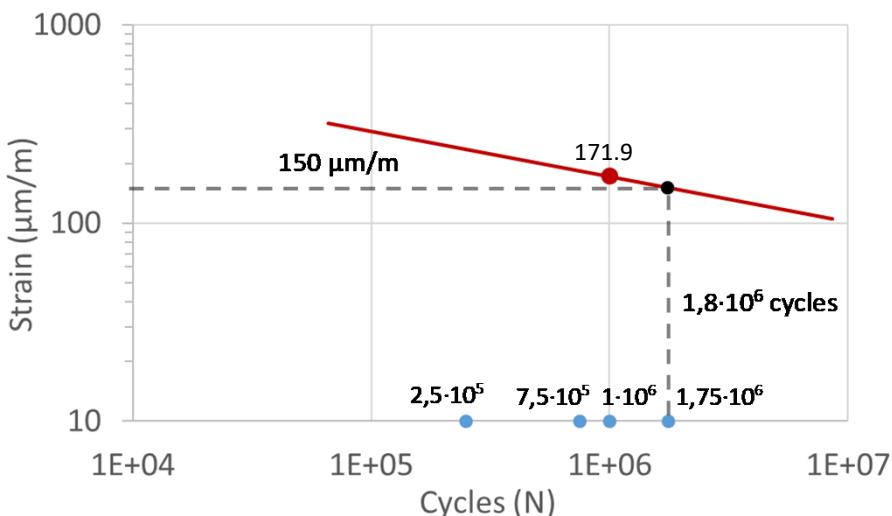


2. HEALING ASSESSMENT

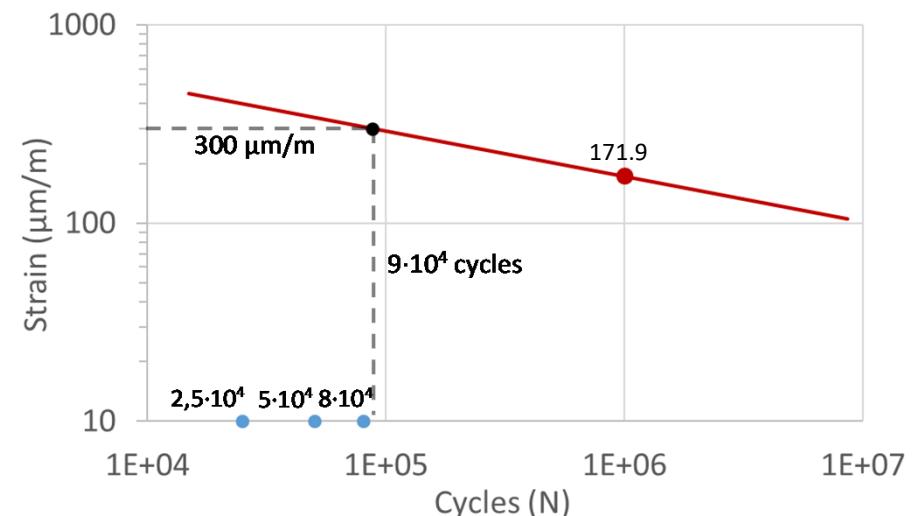
When should the induction healing be applied?

4 point bending test

A. Low deformation ($150 \mu\text{m}/\text{m}$, 1800000 cycles)



B. High deformation ($300 \mu\text{m}/\text{m}$, 90000 cycles)



2. HEALING ASSESSMENT

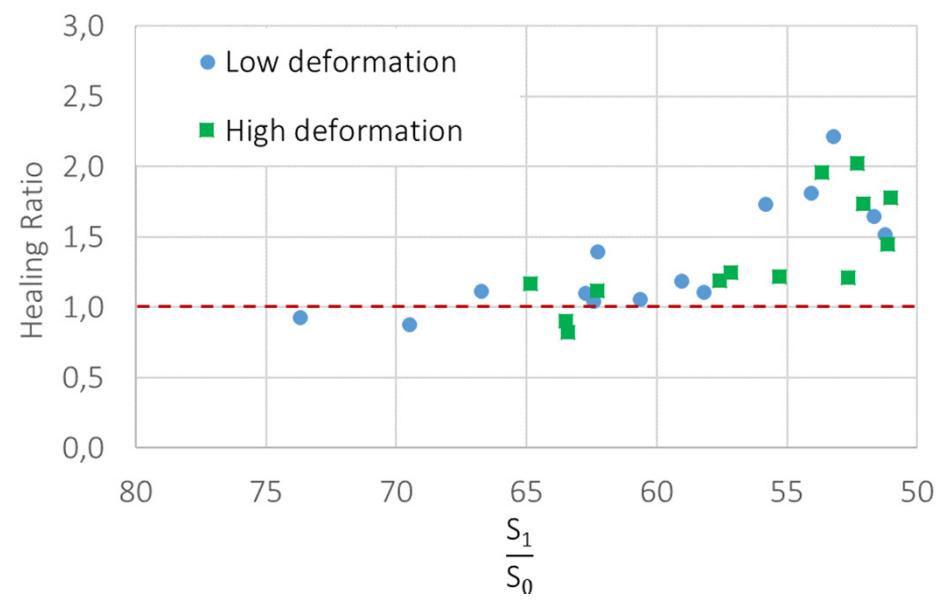
When should the induction healing be applied?

A. Low deformation ($150 \mu\text{m}/\text{m}$, 1800000 cycles)

Fatigue 1		Fatigue 2		Final	
Cycles	$S_1/S_0 (\%)$	Cycles		Cycles	H.R.
250000	70.0	1503853		1753853	1.0
750000	57.3	1088370		1838370	1.0
1000000	61.2	1132370		2132370	1.2
1750000	53.2	1459827		3209827	1.8

B. High deformation ($300 \mu\text{m}/\text{m}$, 90000 cycles)

Fatigue 1		Fatigue 2		Final	
Cycles	$S_1/S_0 (\%)$	Cycles		Cycles	H.R.
25000	63.5	63062		88062	1.0
50000	55.7	56720		106720	1.2
80000	52.0	76884		156884	1.8

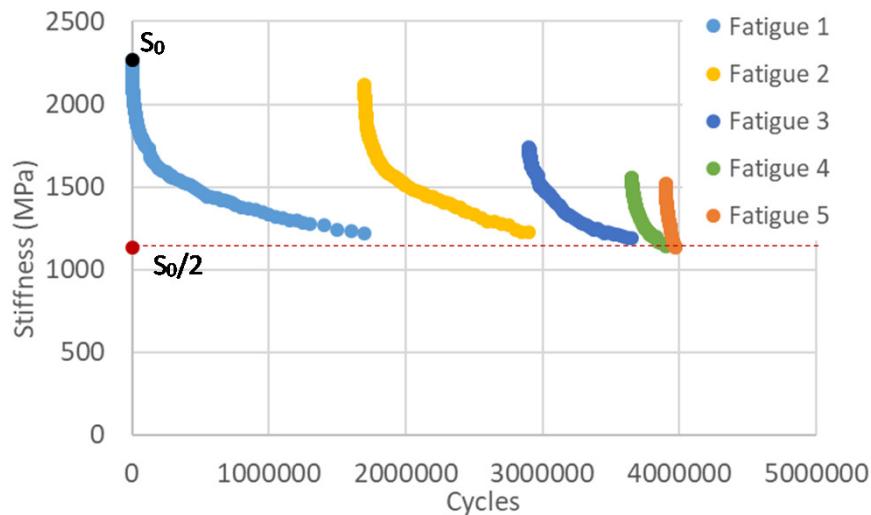




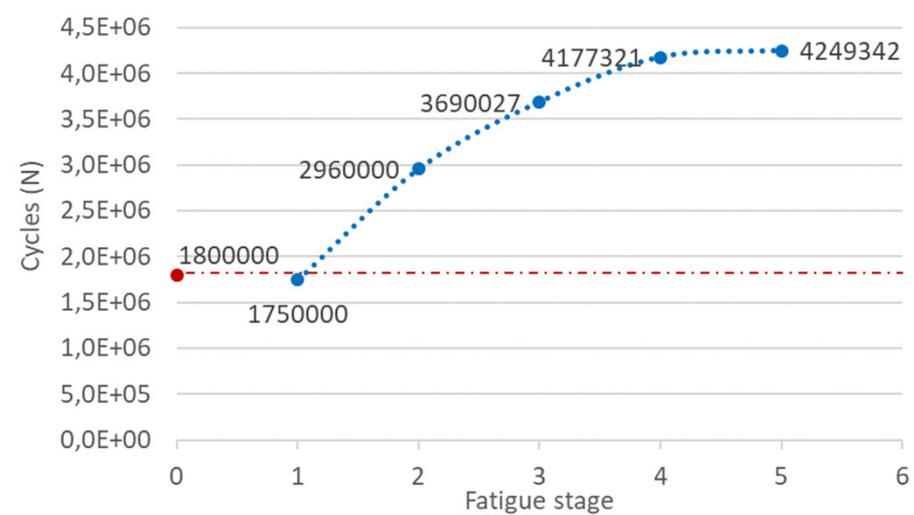
2. HEALING ASSESSMENT

How many times could the induction healing be applied?

Low deformation (150 µm/m, 1800000 cycles)



Fatigue	Cycles	Total cycles	S_1/S_0 (%)	H.R. (%)
1	1750000	1750000	57	-
2	1210000	2960000	63	1,6
3	730027	3690027	57	2,1
4	487294	4177321	56	2,3
5	72021	4249342	50	2,4





3. RECYCLABILITY

Reuse original HEALROAD PA as recycled material

Materials

Original HR PA



Aggregates



Bitumen



Steel wool

Long-term aged HR PA (AASHTO R 30-02)



1 % of steel wool by weight

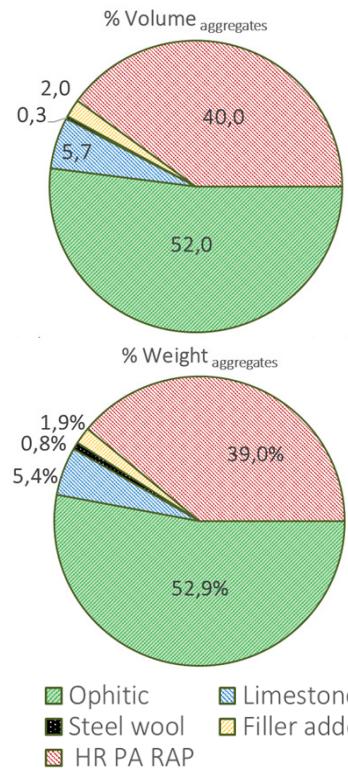
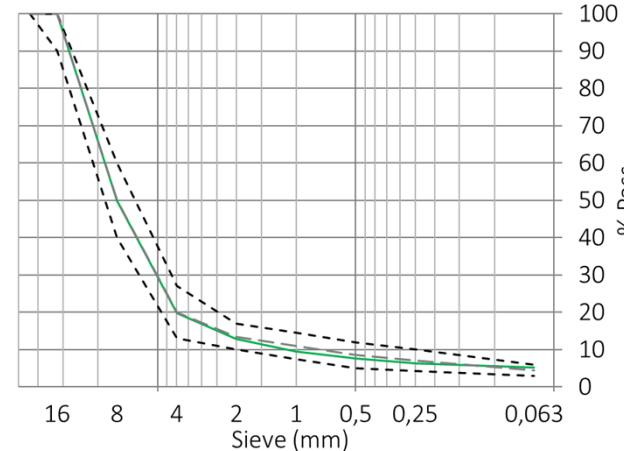
4.5 % of residual binder by weight



Sylvaroad (rejuvenator)

5 % above residual binder

Dosage





3. RECYCLABILITY

Mechanical tests

Voids test (EN 12697-8)

Bitumen / mixture (%)	4.0
Density (g/cm ³)	2.097
Voids in mixture (%)	22.1

Cantabro loss particle test (EN 12697-17)

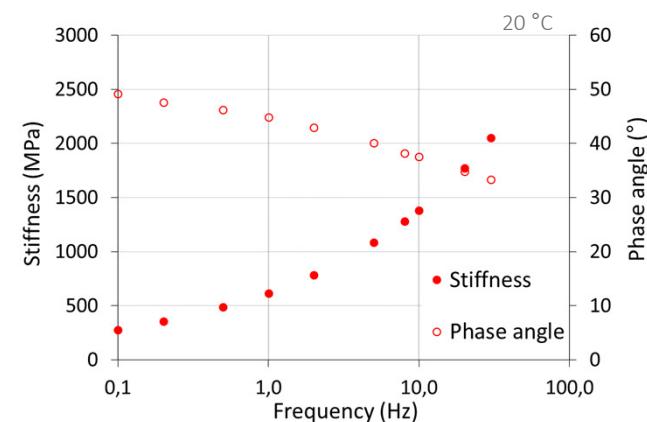
	Dry
Loss particle (%)	17.5

Water sensitivity test (EN 12697-12)

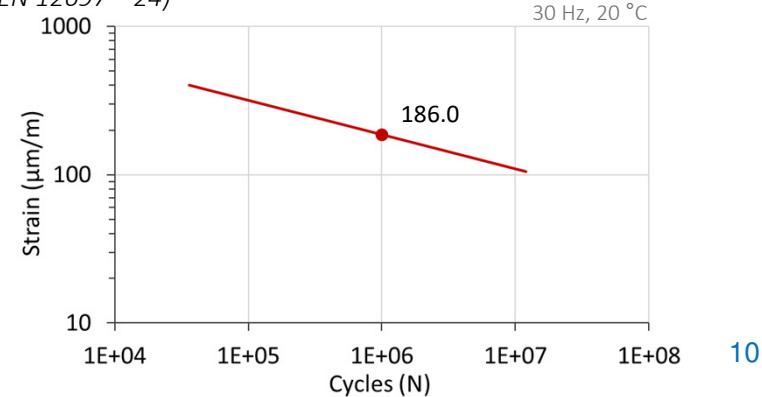
	Dry	Wet
I.T.S. (KPa)	1040.0	864.1
I.T.S.R. (%)		83

Dynamic tests

Stiffness (EN 12697-26)



Fatigue resistance (EN 12697-24)

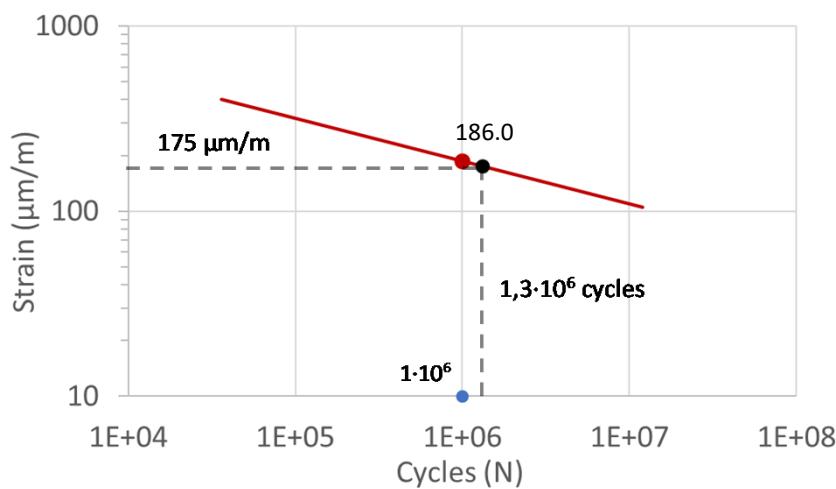




3. RECYCLABILITY

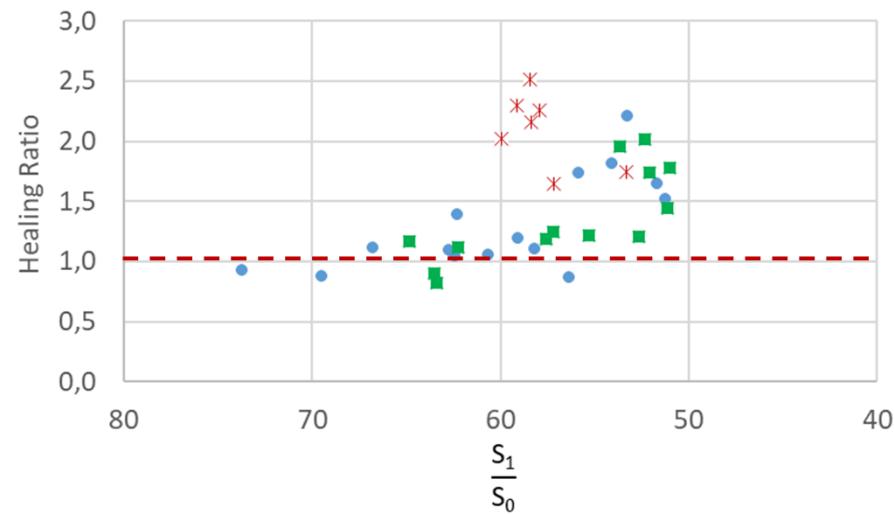
Healing assessment

4 point bending test



Cycles	Fatigue 1	Fatigue 2	Final	
	$S_1/S_0 (\%)$	Cycles	Cycles	H.R.
1000000	57.7	1781621	2781621	2.1

• HR PA Low deformation □ HR PA High deformation * Recycled samples





4. CONCLUSIONS

- The cycles of the second fatigue test (after healing treatment) are similar independently from the cycles of the first fatigue test.
- The healing performance of the Porous Asphalt is independent from the deformation applied, so the deformation does not look like a main parameter of healing process.
- The healing performance is dropped after the third healing treatment. It can be concluded that an optimal long-time performance is obtained with two healing treatments.
- The mechanical performance of the recycled mixture ensures that HR mixtures can be recycled, under a mechanical point of view.
- The healing process of the recycled mixture has worked properly, without differences with the original mixture. This result confirms than the HR mixture could be reused in new healing asphalt mixtures.



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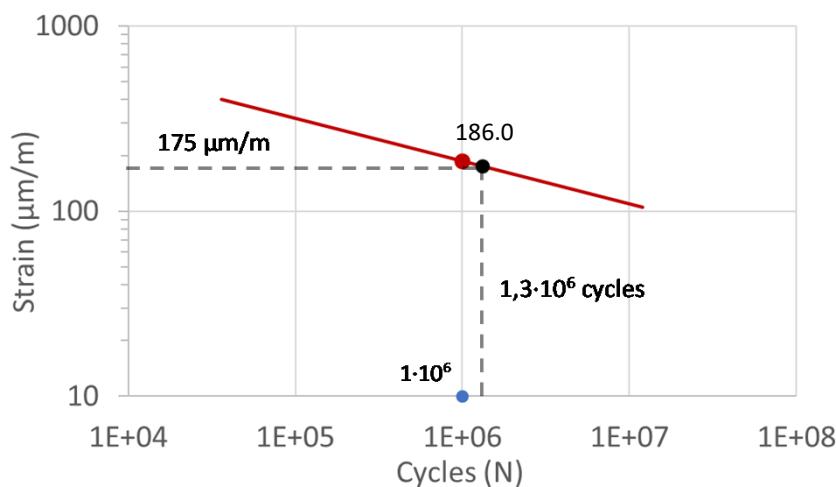




3. RECYCLABILITY

Healing assessment

4 point bending test



Cycles	Fatigue 1	Fatigue 2	Final	
	$S_1/S_0 (\%)$	Cycles	Cycles	H.R.
1000000	57.7	1781621	2781621	2.1

