AV '19 KONFERENCE ASFALTOVÉ VOZOVKY 2019

Evaluating the benefit to pavements of asphalt binders modified with recycled plastic

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SDRUŽENÍ **PRO VÝSTAVBU SILNIC**

ČESKÁ SILNIČNÍ SPOLEČNOST CZECH ROAD SOCIETY

EAPA

PRAGOPROJEKT

Australia

Country	Population (Millions)	Land area (Million km²)
Australia	25.5	7.7
Germany	82.9	0.4
Czech Republic	10.6	<0.1
UK	66.0	0.2
France	65.2	0.6
Italy	60.4	0.3
Spain	46.7	0.5
Ukraine	42.2	0.6
Russia	113.1	3.9
All EU	513.5	4.5
USA	327.2	9.8

Background

Sustainable solutions are increasingly desired

- Recycled asphalt
- Crushed glass in asphalt and concrete
- Waste plastic in concrete and now asphalt

Waste plastic is a growing issue

- 30,000,000 plastic bags in Australia per annum
- 500,000,000 to 1,000,000,000 globally per annum
- Plastic drink bottles are a similar problem

Processed waste plastic as a binder modifier?

Background

Well established that recycled plastic

- Consumes waste destined for landfill
- Reduces demand on bitumen
- Improves asphalt deformation resistance
- Increases asphalt modulus
- Improves asphalt fatigue life

But what does this mean for pavement thickness and/or life?

Background

Recycled plastic modified producer MacRebur

Established in 2015

Based in Scotland

Developed a solution to

- Productively consume local plastic waste
- Reduce the cost of road maintenance
- Increase the strength and durability of roads

First MR 6, then later MR 8 and MR 10

Recycled plastic

MR 6

- 100% waste plastic
- Blended ‘dry’ at any asphalt plant
- Intended to be ‘plastomeric’ (like EVA)

MR 8

- Economical extender without improvement

MR 10

- Different plastics to be ‘elastomeric’ (like SBS)

Recycled plastic

This research is focused on MR 6

Recycled plastic

MR 6

MR 8

MR 10

The question

Can we measure?

- The modulus increase
- The fatigue life improvement

Can we quantify?

- The effect on pavement life
- The effect on pavement thickness

The methods

Standard British SMA 10 mixture (surface)

- Standard 40-60 penetration bitumen (control)
- 6% (of bitumen) of MR 6

Standard British DGM 20 mixture (base)

- Standard 40-60 penetration bitumen (control)
- 6% (of bitumen) of MR 6

Tested to British methods for

- Modulus
- Fatigue life

} *Layered elastic characterization*

The methods

Layered elastic pavement thickness design

- Modulus = structural contribution
- Fatigue life = asphalt cracking criteria

Circly

- Australian layered elastic software
- Developed in 1970s
- Improved and refined
- Official tool for Australian pavement design

The methods

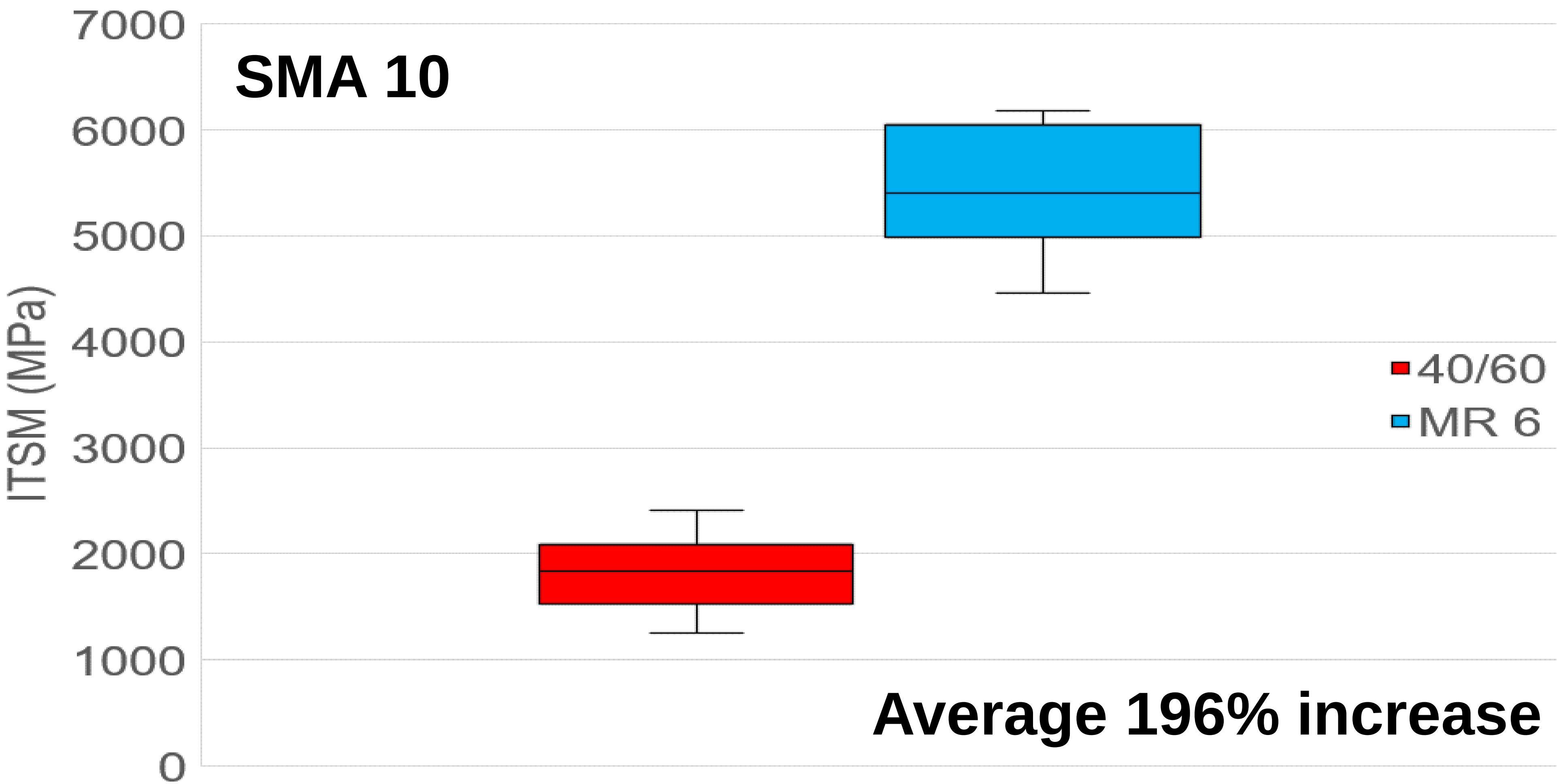
Two styles of pavement

Layer	Local road	Highway
Surface course	50 mm of SMA 10	50 mm of SMA 10
Base course	200 mm crushed rock	As required DGM 20
Sub-base course	As required gravel	150 mm of gravel

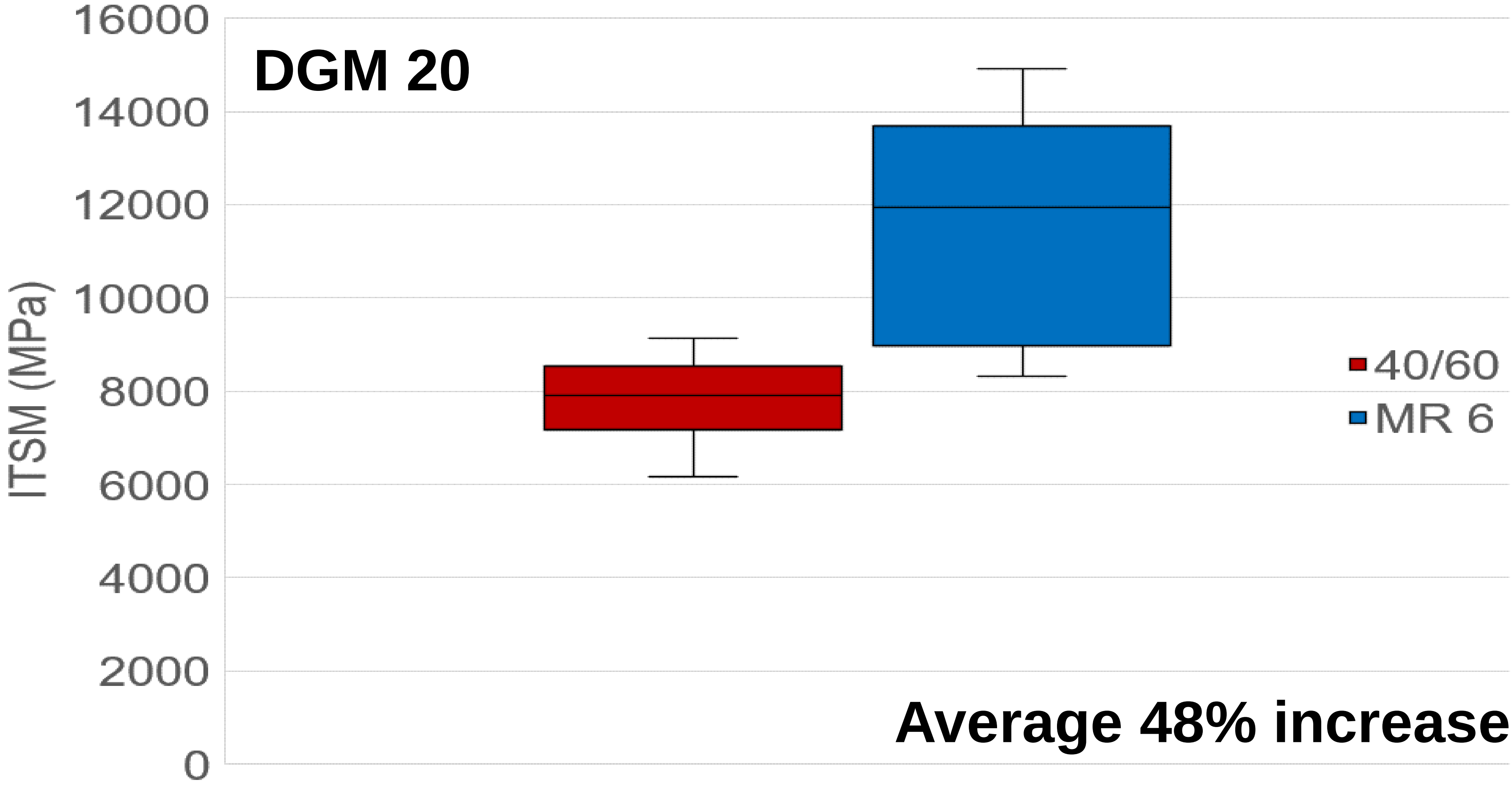
Subgrade – CBR 3, CBR 6 and CBR 10

Traffic – 1×10^6 , 5×10^6 and 1×10^7 ESAs (trucks)

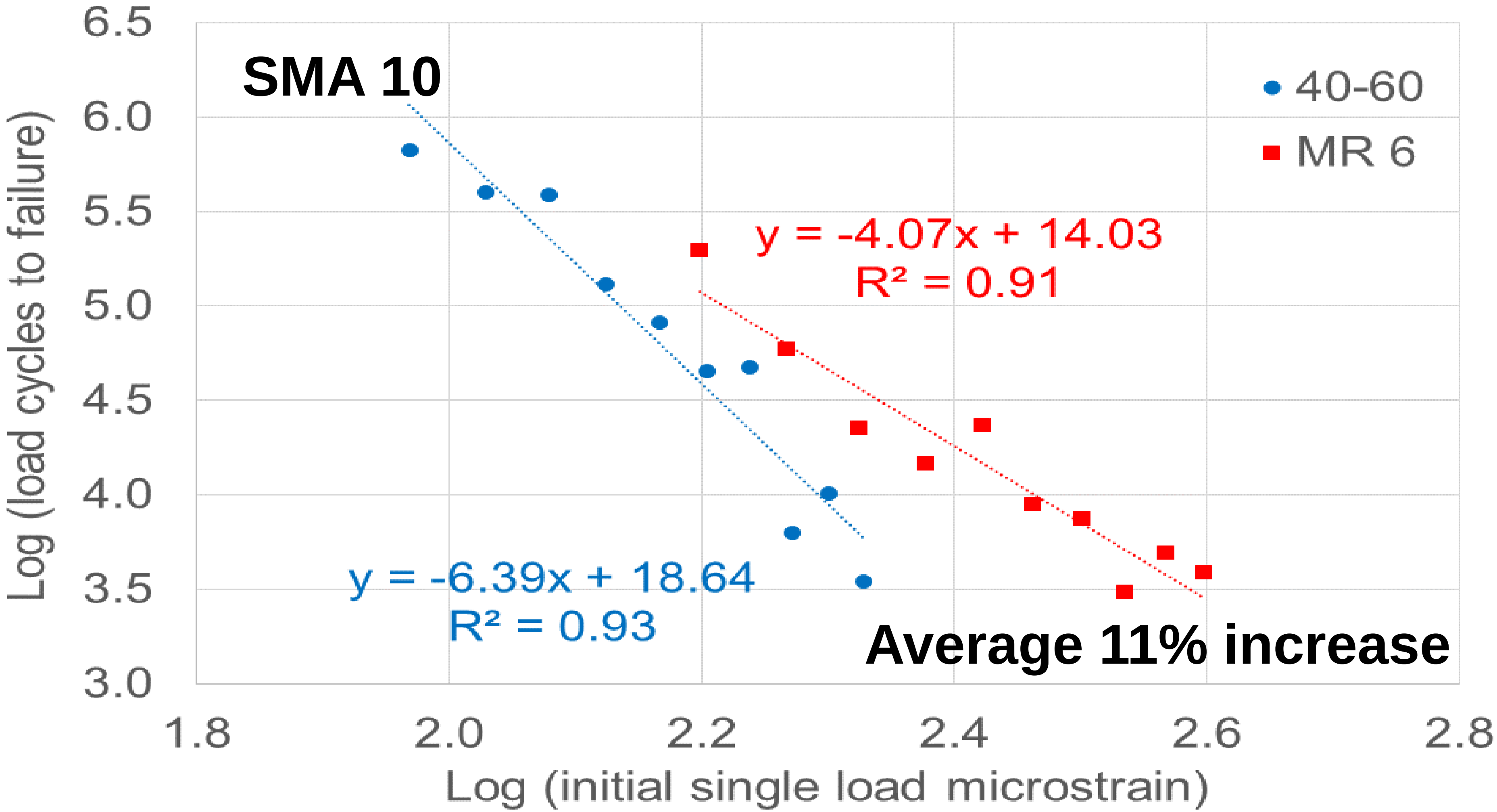
Effect of recycled plastic on modulus



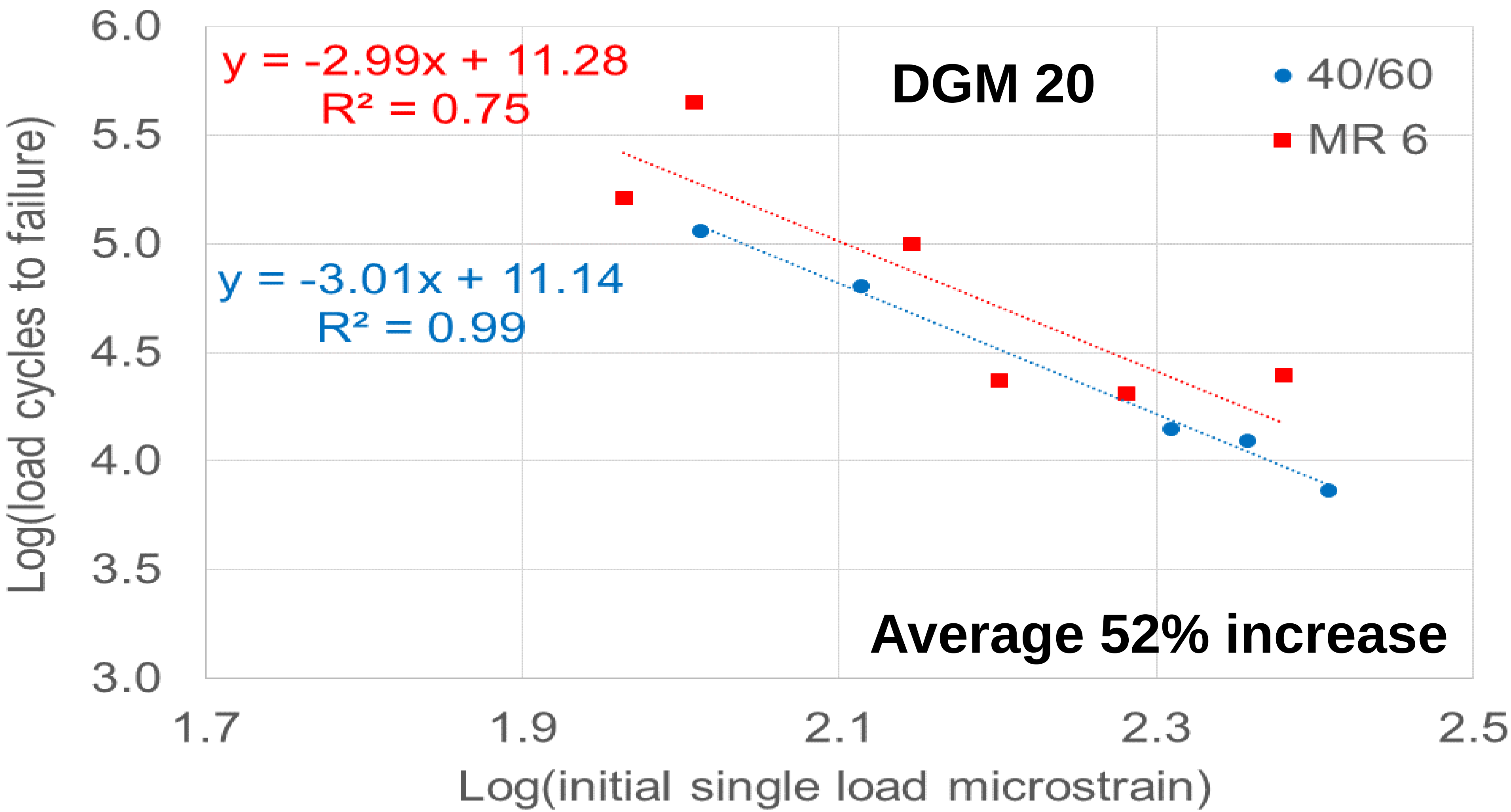
Effect of recycled plastic on modulus



Effect of recycled plastic on fatigue



Effect of recycled plastic on fatigue

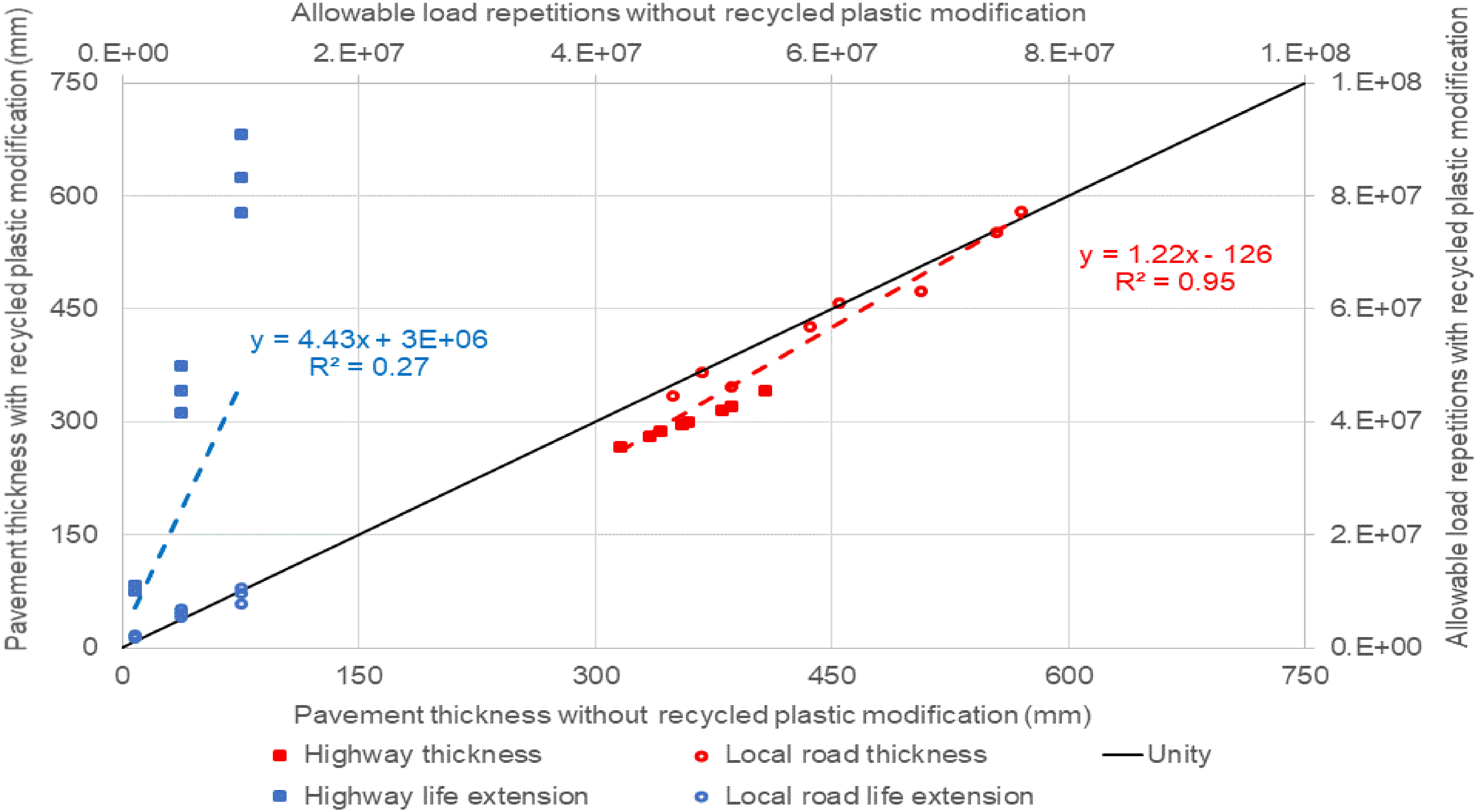


Layered elastic modelling

Material	Standard	With plastic modifier
SMA 10 modulus	3,300 MPa	6,470 (↑ 196%)
DGM 20 modulus	1,500 MPa	2,200MPa (↑ 48%)
SMA 10 fatigue	Shell standard	11% longer
DGM 20 fatigue	Shell standard	52% longer

Granular materials automatically sub-layered

The answers


Allowable load repetitions without recycled plastic modification
0.E+00
2.E+07
4.E+07
6.E+07
8.E+07
1.E+08
Pavement thickness with recycled plastic modification (mm)
750
600
450
300
150
0
Allowable load repetitions with recycled plastic modification
1.E+08
8.E+07
6.E+07
4.E+07
2.E+07
0.E+00
y = 4.43x + 3E+06
R² = 0.27
y = 1.22x - 126
R² = 0.95
0
150
300
450
600
750
Pavement thickness without recycled plastic modification (mm)
Highway thickness
Local road thickness
Unity
Highway life extension
Local road life extension

Conclusions

Recycled plastic can

- Improve asphalt fatigue
- AND
- Increase asphalt modulus

Similar to EVA polymer modified binder

Modelled in layered elastic software

- Three subgrade conditions
- Three levels of traffic
- Local road and Highway pavement

Reduced average thickness by 3% and 16%

Life increased by 150% and 900%


THANKS FOR YOUR ATTENTION