1st International Conference on Stone Matrix Asphalt

November 2018

Atlanta, Georgia

This is in – Thin SMA Surfacing

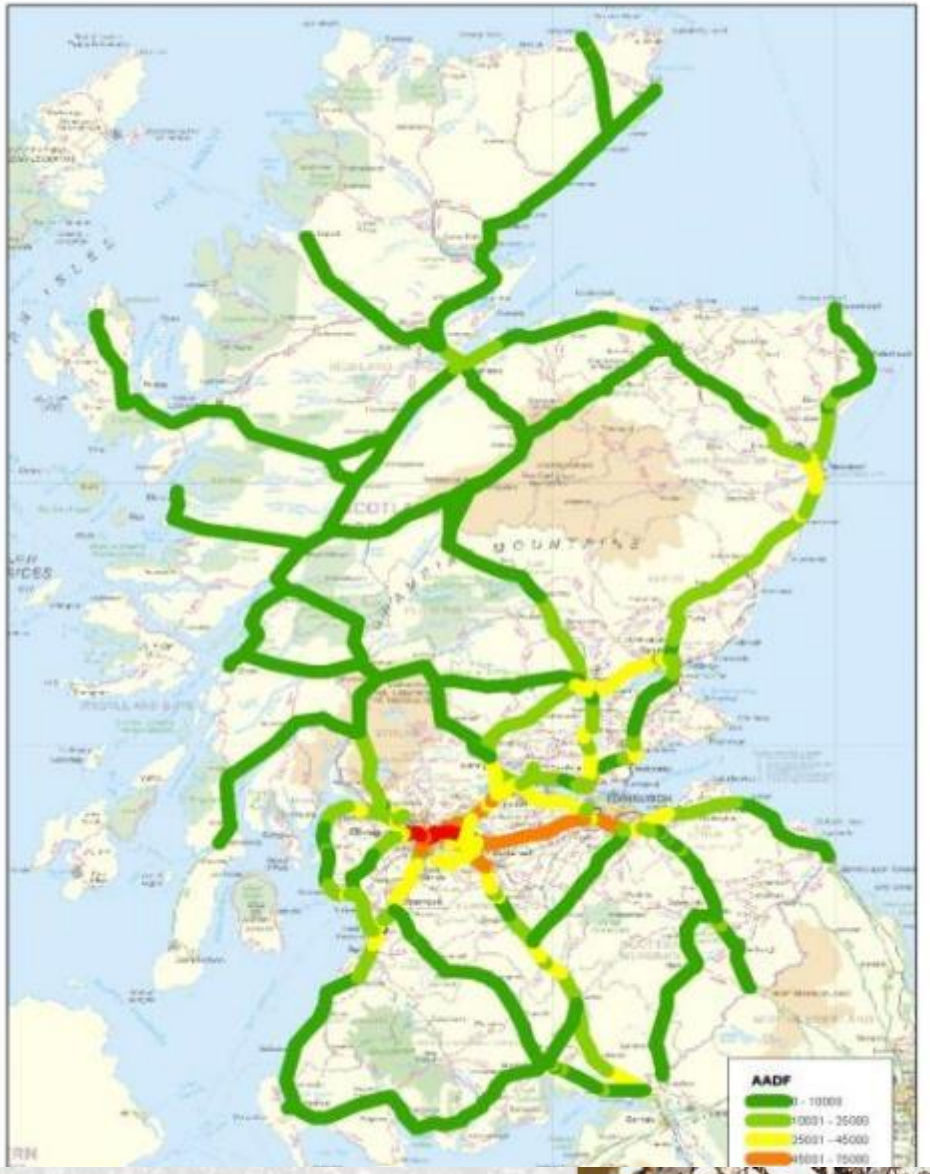
Martin McLaughlin CEng MICE

Head Strategic Asset Management & Customer Strategy

Transport Scotland

This is in – Thin SMA Surfacing

- Who are Transport Scotland?
- History SMA in UK
- Scottish Research
- TS2010 Specification
- Results from implementation
- Thin layers
- Case Study



Role of the Network

TRANSPORT SCOTLAND

- Trunk Road 3,432 km
- Motorways 539 km (16%)
- A roads Dual 512 km (15%)
- A roads Single 2,381 km (69%)
- Local Road 54,776 km

- 6% of total Scottish road network
- 37.5% of all traffic
- 63% of all HGV traffic
- 2,007 bridges and 4,100 other structures

- Asset Value £18 billion
- 4 Operating Companies
- 4 DBFOs

1ST INTERNATIONAL CONFERENCE ON

Stone Matrix Asphalt

TRANSPORT SCOTLAND

TRANSPORT SCOTLAND

1ST INTERNATIONAL CONFERENCE ON

Stone Matrix Asphalt

NAPA NATIONAL ASPHALT PAVEMENT ASSOCIATION

AAPT

TRB

TRANSPORT SCOTLAND

1ST INTERNATIONAL CONFERENCE ON

Stone Matrix Asphalt

NAPA NATIONAL ASPHALT PAVEMENT ASSOCIATION

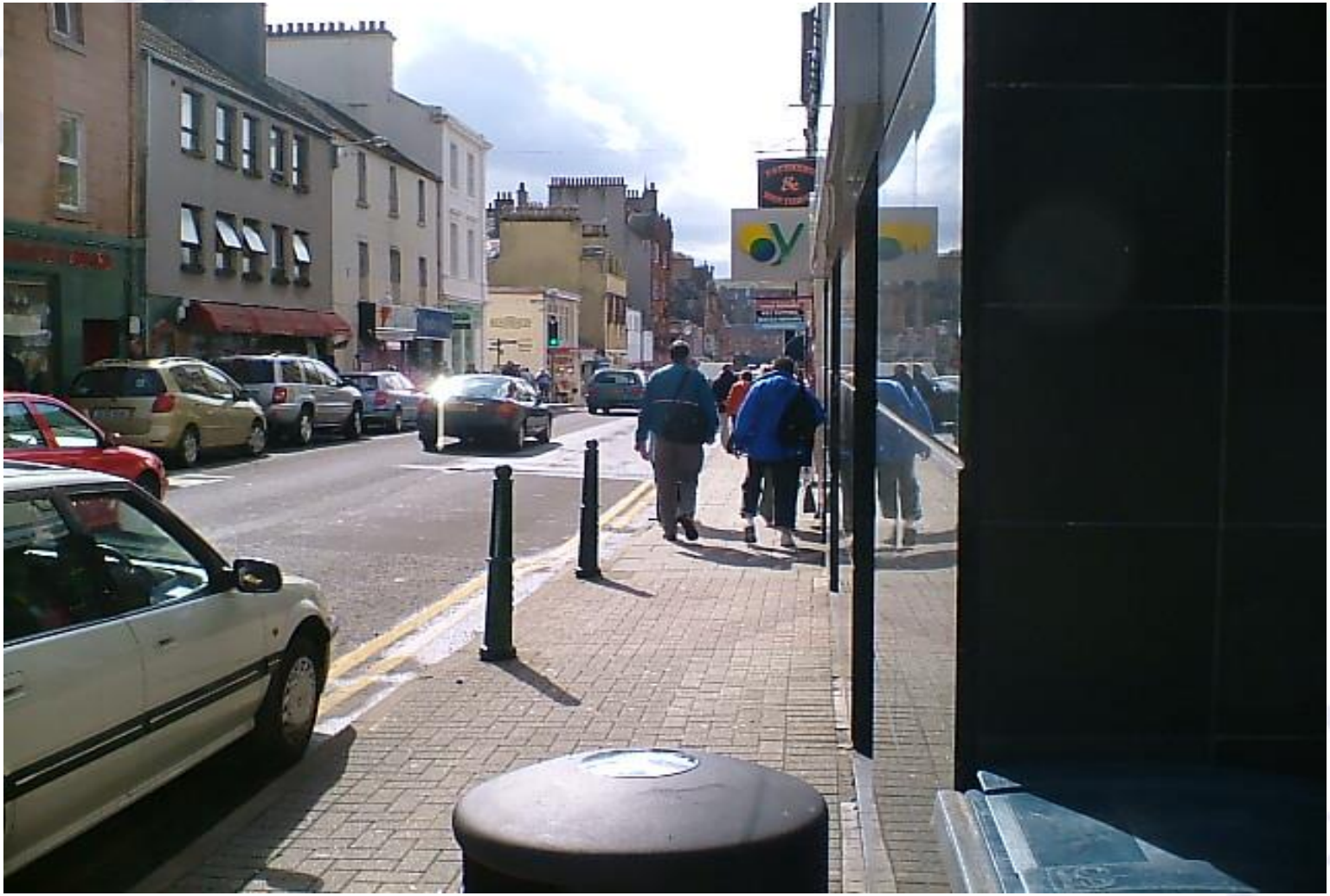
ASPHALT INSTITUTE

AAPT

TRB

U.S. TIRE MANUFACTURERS ASSOCIATION

TRANSPORT SCOTLAND



Brief History

- HRA most common until mid 1990s

- Generally long service
- Rutting Problem

Brief History

- SMA Introduced to UK mid 1990s
- Quickly became popular:
  - High resistance to rutting
  - Smaller working crew size
  - Quicker to lay than HRA
  - Reduced working space requirements
  - Quieter than Hot Rolled Asphalt (HRA)

Europe to UK

- German SMA + French UL-M
- New concepts:
  - Mechanical interlock (stone to stone)
  - Thin layers (25mm thickness)
- Coarse + fine aggregate bound in mastic
- Mixtures may contain fibres or polymers
- Texture requirements added in UK
- Proprietary Thin Surface Course System

Clause 942 Thin Surface Course

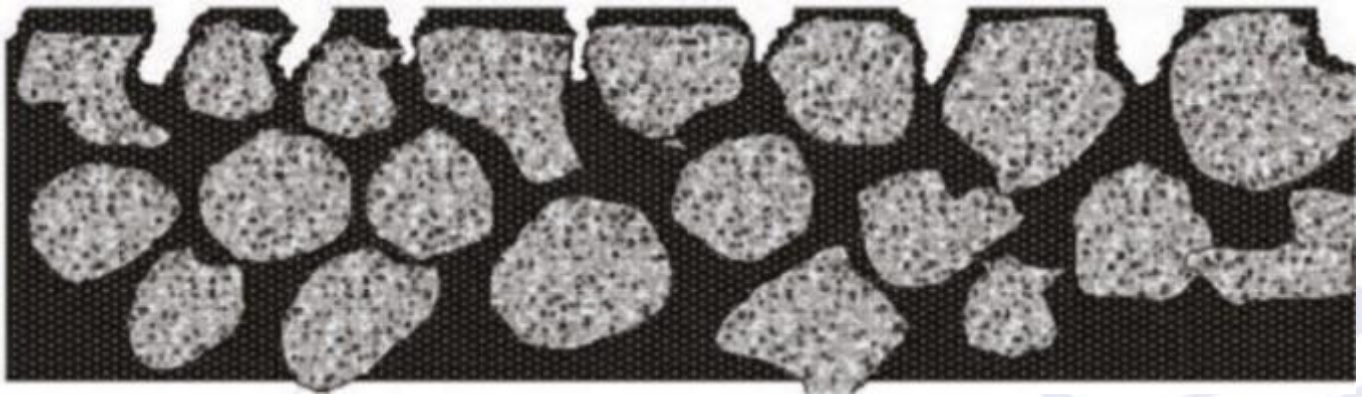
Micro-texture

Macro-texture

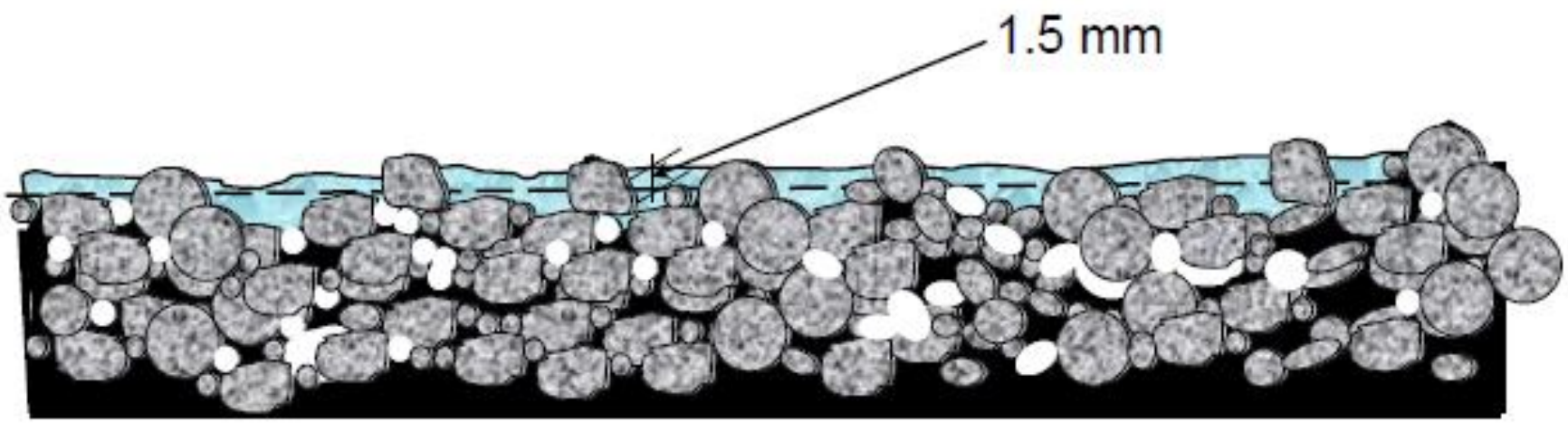
TRANSPORT SCOTLAND

Positive Texture

Negative Texture



Effect of Texture



2006 review durability

- Poor Performance of Thin Surfacing
- Leading to reduced Value for Money
- Reduced sustainability
- User disruption
- Public Perception - ‘potholes’

Scottish Inspection Panel

- Academic, Industry, Client
- 7 point scale developed by TRL
- Panel average score (6-8 people)
- Week long inspection tour
- Random selection +2 year pavements
- Annual event

2006 review - Observed defects

Houston – we have a problem

RANSPORT
COTLAND

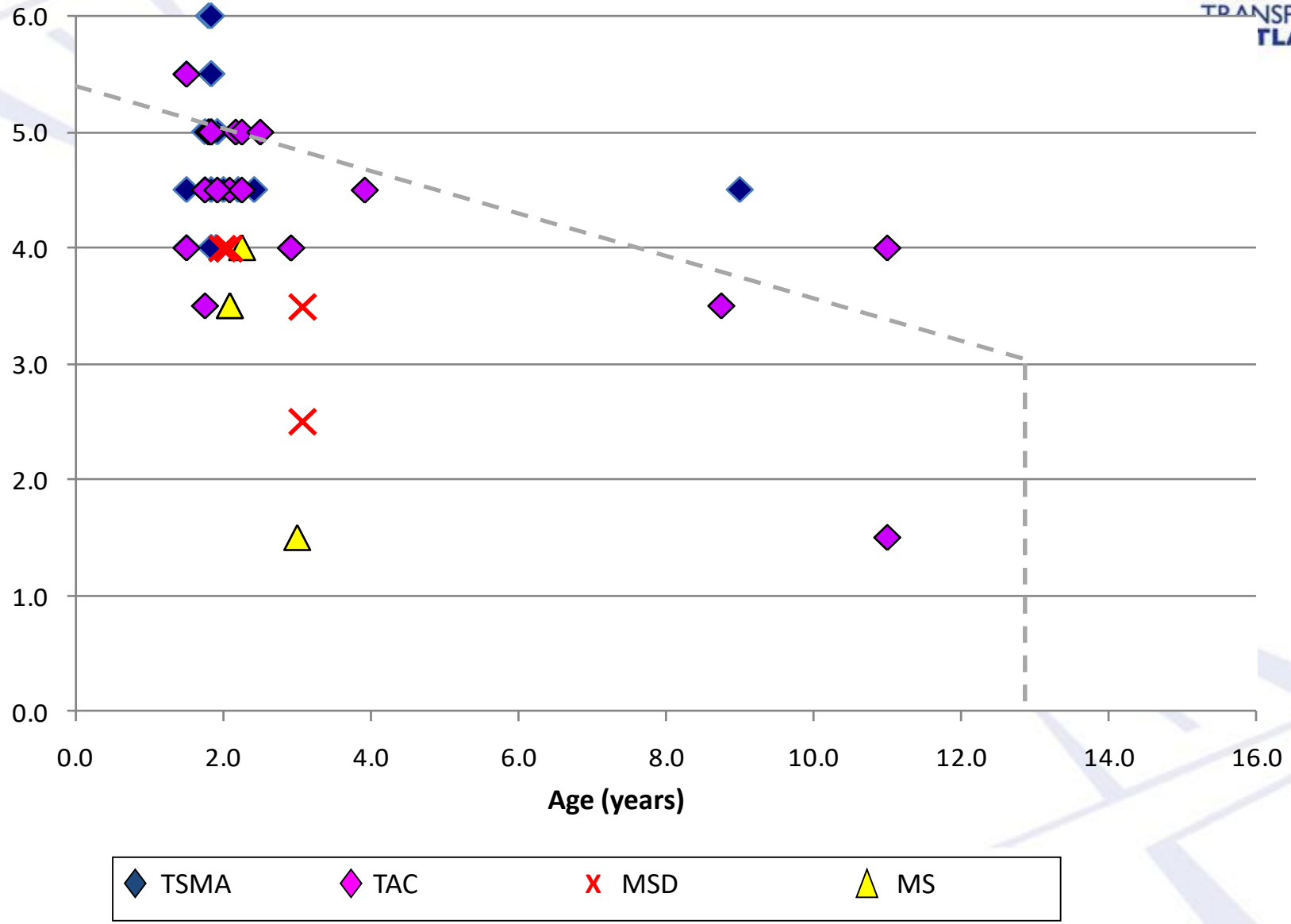
1ST INTERNATIONAL CONFERENCE ON
Stone Matrix Asphalt

NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION
AAPT
TRB

Scottish Inspection Panel

- Summary Findings
  - Poor performance of Thin Surfacing
  - Fatting & flushing
  - Ravelling joints & fretting
  - Open texture & high air voids
  - General durability concerns
  - Workmanship
  - Allowed a focus on areas on concern

Average visual condition markings - 2006



Research Project

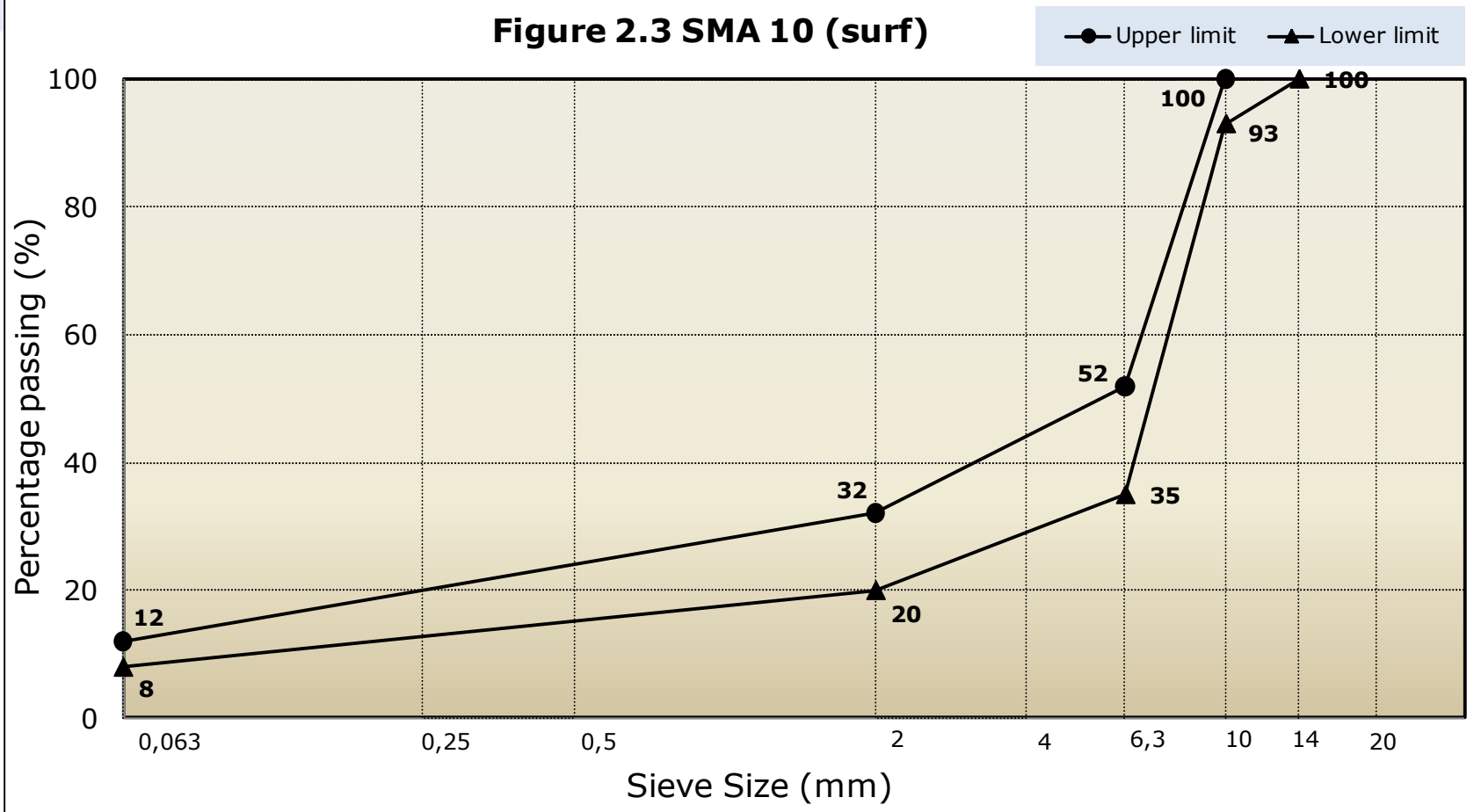
- Fact finding trip on the use of SMA in Germany
- Application and Experience
- Specifications
- Practice of pre-gritting SMA
- Test site on M8 motorway

TS 2010 - Specification

- What are the differences?
  - Very tight specification
    - Gap grading & binder content (+ 0.5% to 1.0%)
    - Polymer modified (SBS) + fibres – Step change
    - Air voids requirement
  - No texture or PSV requirement
  - Introduction of gritting
  - Performance Specification
    - Skid Resistance (4 weeks + 6 months + annual)
  - Controlled implementation
    - Type Approval Installation Trial (TAIT)

Gap Grading (6, 8, 10,14)

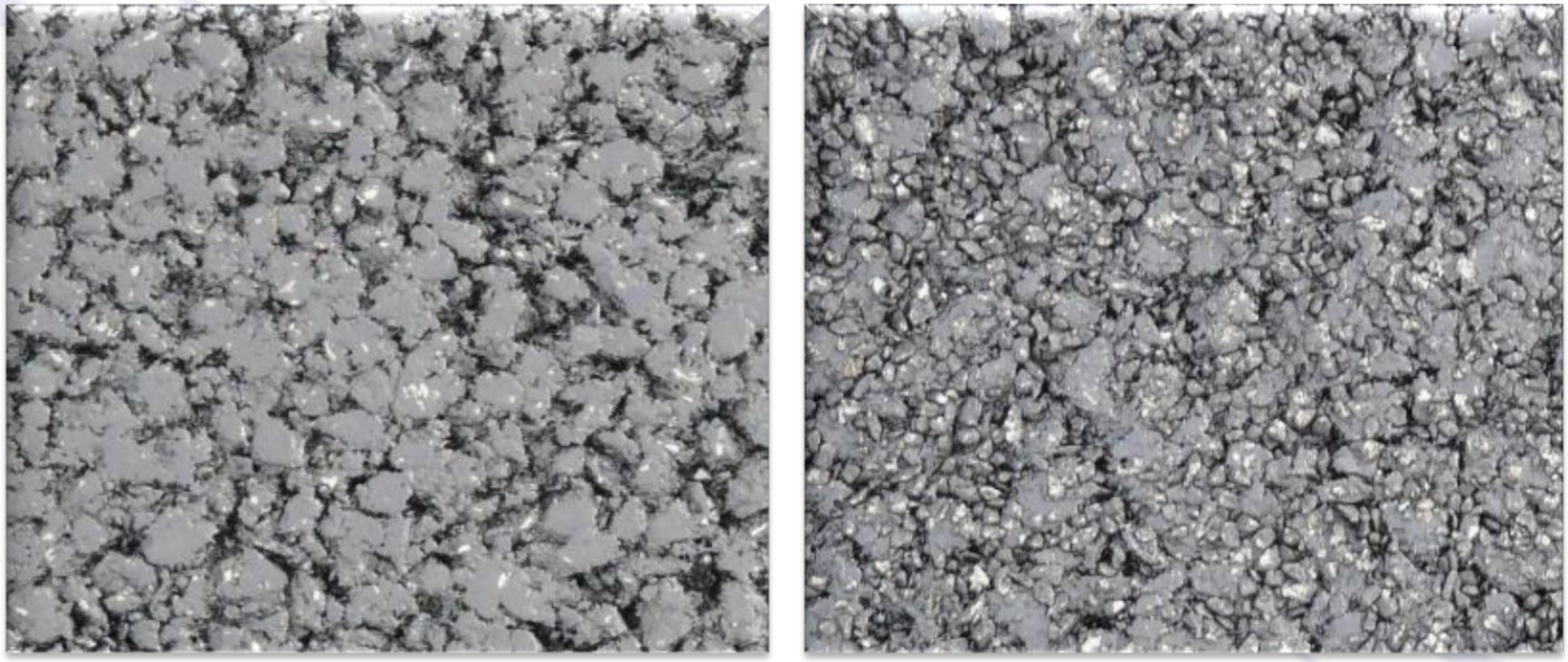
TRANSPORT SCOTLAND



TS2010 SMA

TRANSPORT SCOTLAND

Gritting



0/14mm before (left) and after (right) gritting

Gritting Roller

TS2010 benefits

- Superior durability
- Better value + sustainability
- High resistance to permanent deformation (low air voids)
- Good skid resistance, including early-life
- Low noise levels
- Better use of local aggregates

TS2010 Approval

- Type Approval Installation Trial (TAIT)
- 3 Stage process

- Stage 1 – Lab mix design
- Stage 2 – Off network paver laid trial
- Stage 3 – Trunk road surfacing trial

Rigorous Approval Procedure Stage 1 Lab design

Table 2.1: Stage 1 compliance results

Test	Requirement	Value	✓/×
Coarse aggregate apparent particle density	Declared	2.97kg/m^3	✓
Coarse aggregate resistance to polishing	$PSV_{declared}$	61	✓
Coarse aggregate resistance to abrasion	AAV_{12}	3.2	✓
Coarse aggregate resistance to fragmentation	LA_{30}	13	✓
Coarse aggregate resistance to wear	$M_{DE\ declared}$	8	✓
Flakiness	FI_{20}	17	✓
Air voids SMA 10 (Surf)	V_{min3}, $V_{max3.5}$	3.5%	✓
Binder content	6.7% ±0.2%	6.7%	✓
Binder penetration (Nypol 103)	75 – 130	94/109	✓
Binder softening point	>=75	91/91.5	✓
Binder drainage	$D_{0.3}$	0.1%	✓
Resistance to permanent deformation	Declared	0.04mm/10^{3}cycles	✓

Stage 2 Off site trial

TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

ANSPORT
COTLAND
HDHAIL ALBA

Stage 2 compliance results

Test	Requirement	Value	✓/✗
Air voids in mat	V_{min2}, V_{max5}	3.0%	✓
Binder content	6.7% ±0.02%	6.7%	✓
Texture gritted material	declared	1.0mm	✓
Texture ungritted material	declared	1.1mm	✓

Stage 3: In situ skid resistance measured by the griptester

Skid performance class awarded based on performance

Test required On appropriate Site class

Site Class	HD 28/04 Site Category[a)]	Measuring speed[d] (km/h)	Minimum mean Grip Number (10m Average)	
			After 4 weeks trafficking	After 6 months trafficking
1	A, B & C	50	0.39	0.56
2	R, G1 & S1	50	0.51	0.62
3	Q, K, G2 & S2	50	0.56	0.67

Stage 3: In situ skid resistance measured by the griptester

Skid perf
class aw
based or
performa

Test rec
On app
Site cla

rip
er 6 nths cking
56

SCRIM performance

TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

TS2010 Material	Site Class 1	Age at SCRIM Survey	0			1			2			3			4			5			6		
			Average CSC			Average CSC			Average CSC			Average CSC			Average CSC			Average CSC			Average CSC		
			Avg SCRIM Diff	Length(m)	Length SCRIM +ve	Avg SCRIM Diff	Length(m)	Length SCRIM +ve	Avg SCRIM Diff	Length(m)	Length SCRIM +ve	Avg SCRIM Diff	Length(m)	Length SCRIM +ve	Avg SCRIM Diff	Length(m)	Length SCRIM +ve	Avg SCRIM Diff	Length(m)	Length SCRIM +ve	Avg SCRIM Diff	Length(m)	Length SCRIM +ve
TS2010 AI01	Site Class 1		0.48			0.47			0.46			0.45			0.46			0.43			0.50		
			0.13	25211	90%	0.12	43312	98%	0.11	33426	95%	0.10	24006	99%	0.11	9414	100%	0.07	1120	100%	0.13	1120	100%
TS2010 AI01	Site Class 2		0.67			0.51			0.39			0.41											
			0.22	100	100%	0.06	60	100%	-0.06	550	0%	-0.04	550	27%									
TS2010 AI01	Site Class 3					0.50			0.50			0.46											
						0.01	1023	44%	0.02	640	70%	-0.04	70	0%									
TS2010 AI03	Site Class 1		0.50			0.53			0.47			0.49			0.51			0.46					
			0.13	1903	95%	0.16	6615	100%	0.10	6038	98%	0.13	3955	100%	0.15	3145	100%	0.11	400	100%			
TS2010 AI03	Site Class 2		0.53			0.53			0.40			0.47			0.48								
			0.07	1060	86%	0.08	432	100%	-0.05	502	16%	0.02	492	55%	0.03	422	95%						
TS2010 AI03	Site Class 3		0.53			0.51			0.45			0.50			0.51								
			0.03	840	66%	0.02	1991	56%	-0.04	1343	27%	0.00	798	19%	0.01	383	100%						
TS2010 AI04	Site Class 1		0.44			0.50			0.50														
			0.08	1030	100%	0.13	2260	98%	0.15	1030	100%												
TS2010 AI04	Site Class 3		0.44			0.52			0.48														
			-0.01	50	0%	0.07	50	100%	0.03	50	100%												
TS2010 AI05	Site Class 1					0.54			0.44			0.49			0.50								
						0.19	200	100%	0.09	200	100%	0.14	200	100%	0.15	200	100%						
TS2010 AI06	Site Class 1		0.42			0.47			0.52			0.56											
			0.07	740	100%	0.11	890	100%	0.17	740	100%	0.21	210	100%									
TS2010 AI06	Site Class 2		0.52			0.55			0.55			0.56											
			0.07	310	100%	0.10	480	100%	0.10	310	100%	0.11	310	100%									
TS2010 AI07	Site Class 1		0.46			0.51			0.51			0.53											
			0.07	1145	98%	0.12	1685	99%	0.12	1685	99%	0.13	540	100%									
TS2010 AI07	Site Class 2		0.53			0.49			0.54			0.54											
			0.08	90	100%	0.04	270	67%	0.09	270	96%	0.09	180	100%									
TS2010 AI07	Site Class 3		0.46			0.48			0.54			0.54											
			-0.04	295	44%	0.02	990	59%	0.08	1025	93%	0.08	730	100%									

Design Ref No.	Agg. Size	stage 3 Trial TD
AI 01	0/10	1.1
AI 03	0/10	1.1
AI 05	0/6	0.8
AI 06	0/10	1.0
AI 07	0/10	1.1
Br 01	0/10	1.2
Br 02	0/10	1.3
Br 04	0/10	1.1
Br 05	0/14	1.5
Br 06	0/10	1.0
Br 07	0/10	1.0
Br 09	0/10	1.0
Br 10	0/10	1.1
Br 11	0/10	1.0
Br 12	0/10	0.9
Br 13	0/06	1.0
Hi 01	0/10	1.1
Le 02	0/10	1.2
Le 03	0/06	1.1
Tar 01	0/10	1.0
Tar 03	0/10	1.2

Texture ?

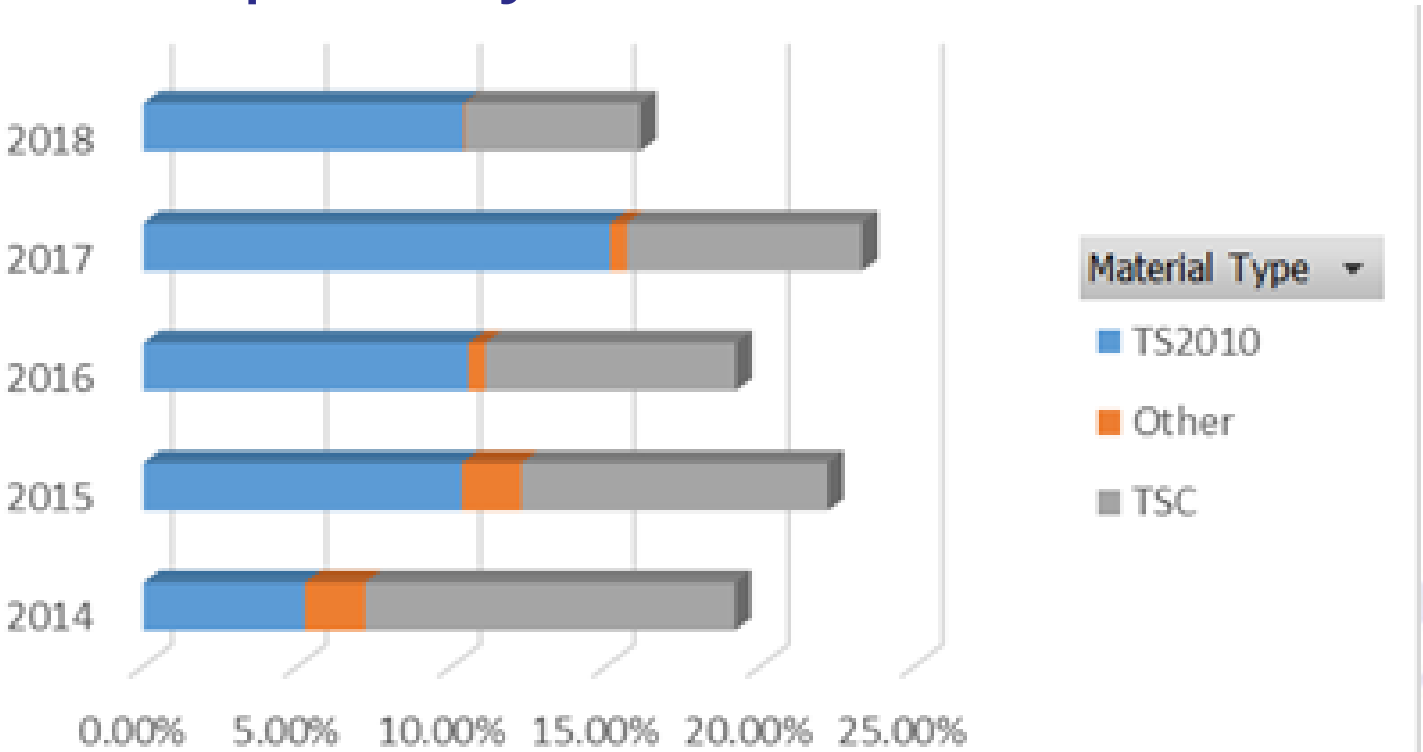
TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

- No texture requirement … but …

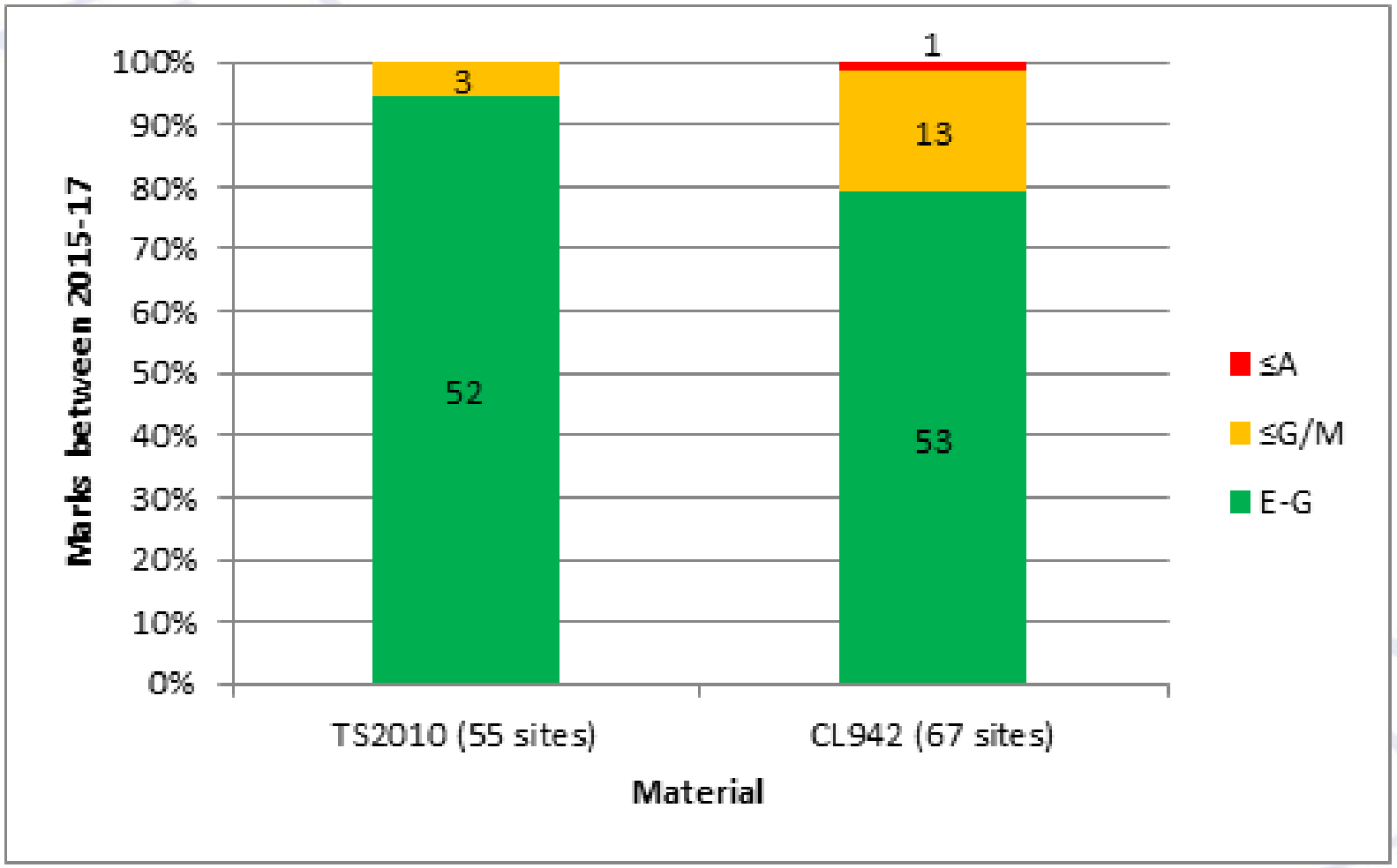
Agg Size	10mm	6mm
Ave texture measured	1.1	1.0
Texture range measured	0.9 - 1.3	0.8 – 1.1
942 required average	1.1 - 1.6	1.0 – 1.5
942 required min	0.9	0.9

TS2010 - Latest Stats

- 1200 lane km – approx. 12% network
- >50% over past 5 years

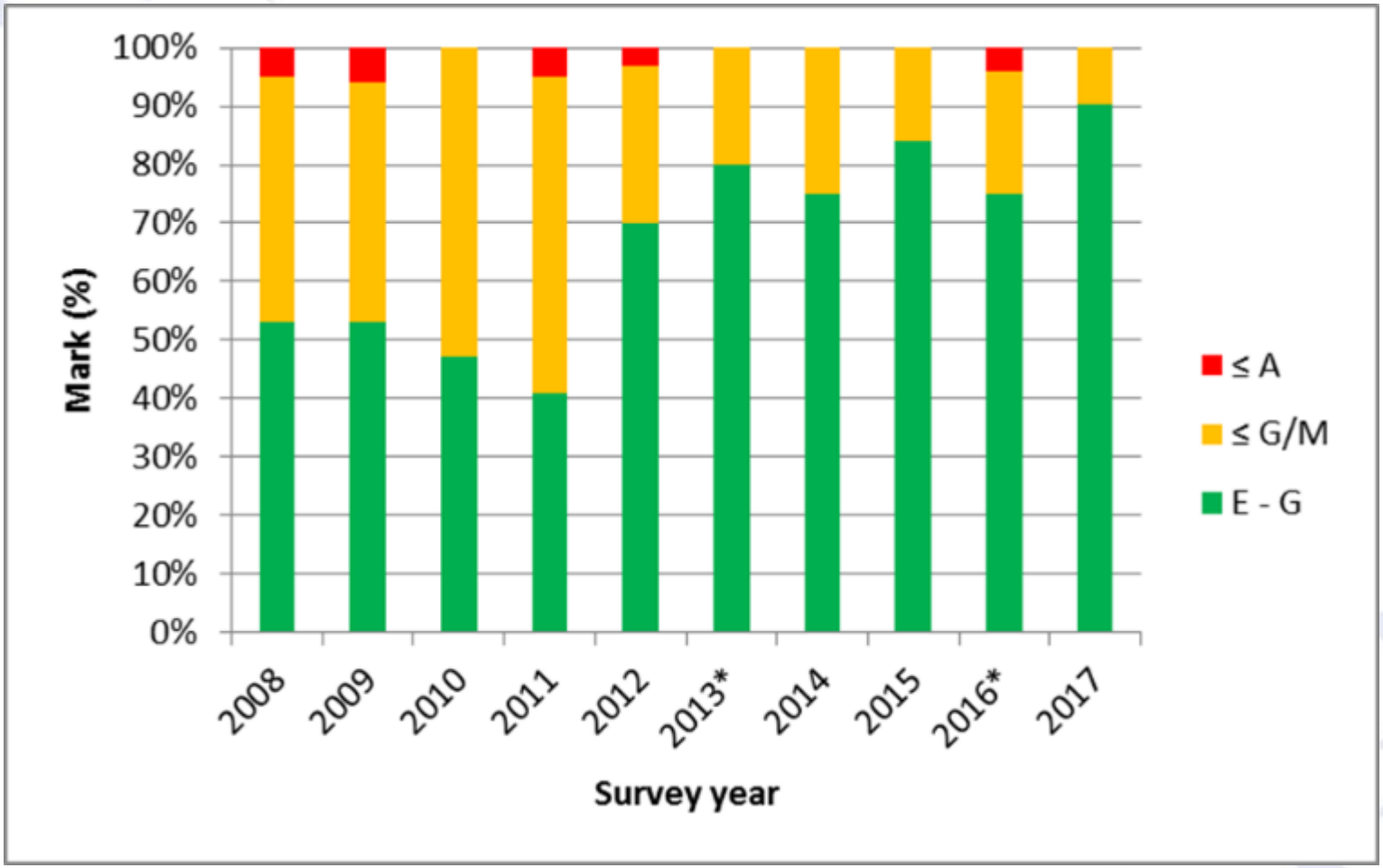


Latest Information – 2 years



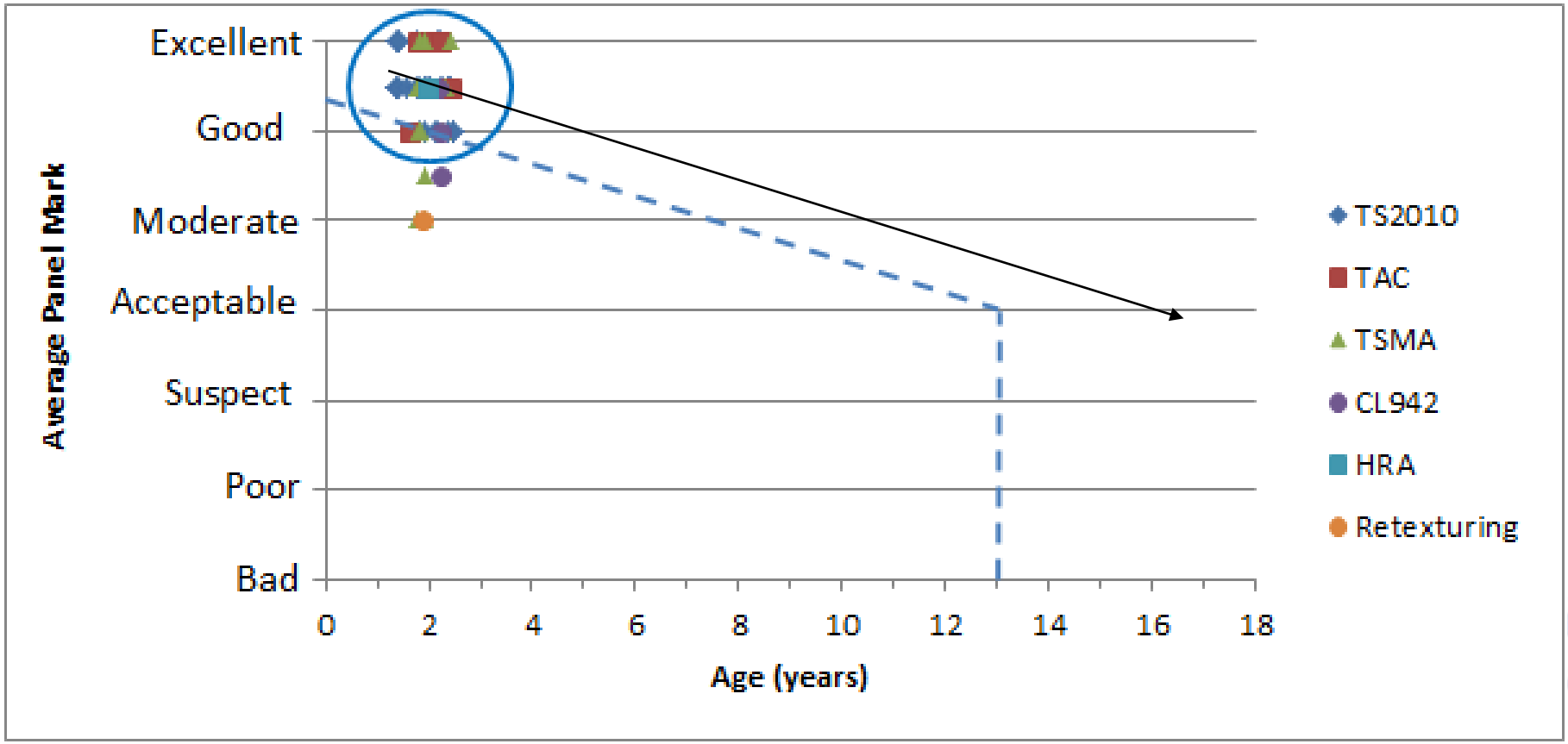
Latest Findings

Scottish Surface Inspection Panel
~40 2 year old sites randomly selected across the network each year



A- just acceptable, G/M – No serious issue G/E – performing well

Rate of Deterioration



Whole Life Cost Analysis

TRANSPORT SCOTLAND

- Typical costs around 15% higher …
- Last twice as long

- Lifecycle savings calculated around 14%
- Equates to £2m per year saving

- We can't afford not to do it !

Recent UK Developments

- Amended Clause 942
- New Clause 941
- Minimum texture requirements lowered
- Maximum texture requirements added
- PSV requirements relaxed
- Aggregate size restrictions added
- Minimum binder contents added
- Void content requirement added

Minimum thickness requirement

Mixture description	Thickness range mm (inches)	Minimum thickness at any one point mm (inches)
SMA 6 (0.24)	20 – 40 (0.79 – 1.57)	15 (0.59)
SMA 8 (0.31)	20 – 40 (0.79 – 1.57)	16 (0.63)
SMA 10 (0.39)	25 – 40 (0.98 – 1.57)	20 (0.79)
SMA 14 (0.55)	35 – 50 (1.38 – 1.97)	30 (1.18)

Why thin?

- Cost saving
- Whole Life cost
- More sustainable use of aggregate
- Consider Stiffness
- When Thin?
  - New binder course
  - Good line + level
  - Favourable weather
- When not thin?
  - Thicker HRA layer
  - Poorer bond beneath
  - Colder conditions

Consider Stiffness

Mixture	Indirect Tensile Stiffness (MPa)
SMA 10 Cairneyhill	1036
SMA 6 Jericho Bridge	660
SMA 6 Cairneyhill	560
SMA 10 Ballystockart	1993
SMA 10 Ballystockart	1678

M90 Concrete Carriageway

- Jointed Unreinforced concrete pavement
- 40+ years old
- Micro-surfacing failure
- 6mm SMA + SBS polymer at 25mm

Summary

- Legacy TSC persists
- Success from failure
- New SMA is working
- Better control + durability
- Whole Life Cost value
- “If you’re going to do SMA, do it right”
- We can’t afford not to

Thank you

- More Information
- https://www.transport.gov.scot/transport-network/roads/design-of-trunk-roads/#45115

- https://trl.co.uk/reports/TRL670

- Please get in touch
- martin.mclaughlin@transport.gov.scot

Thank you for your attention