A performance review of Ex Situ Cold Recycled Bound Material (CRBM) in the UK

Asphalt Recycling Technologies workshop 2025

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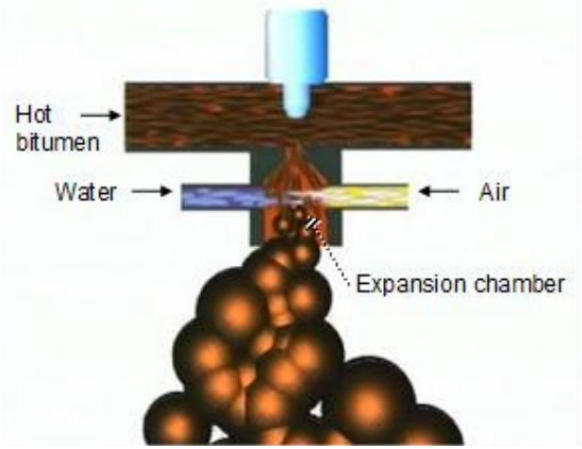
What is ‘Cold Recycled Bound Material’?

- ‘Aggregate’
  - Not heated
  - Recycled*
- Binder
  - Bitumen
    - Foamed
    - Emulsion+
  - ‘Hydraulic’
    - Cement
    - Lime+
- Filler



Used as a structural (base) layer

***Normally**
+Low volume roads only

CRBM options in the UK

Four material types, but only (foamed) QVE is used on major trunk roads

	No bitumen	Bitumen
Lime	Slow hydraulic (SH) 	Slow Viscoelastic (SVE)  
Cement	Quick Hydraulic (QH) 	Quick Viscoelastic (QVE)  

Rigid material (like HBM)

Assumed flexible material (like asphalt)

In situ or ex situ

Photos: Wirtgen, SPL, OCL

Background to CRBM in the UK

- Introduced to encapsulate tar-bound materials and avoid costly hazardous waste disposal.

- First used on the Trunk Road network in 2002.

- Since 2006, CRBM use has been limited to up to 30 million standard axles traffic due to lack of (empirical) performance evidence. However, due to traffic volume growth this limits usage to circa 25% of the trunk road network.

Pavement design assumptions for QVE CRBM in the UK

Multi-layer linear elastic analysis

Zone	28-day IT-CY	Design stiffness	Asphalt equiv.
B1	1900 MPa	1900 MPa	AC 160/220
B2	2500 MPa	2500 MPa	AC 100/150
B3	3100 MPa	3100 MPa	HRA 40/60
B4	4700 MPa	??? No design curves	

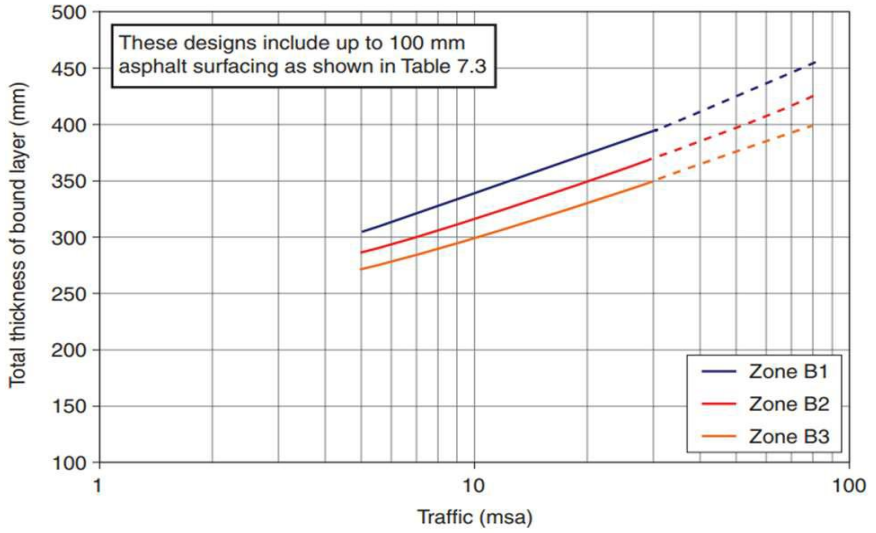
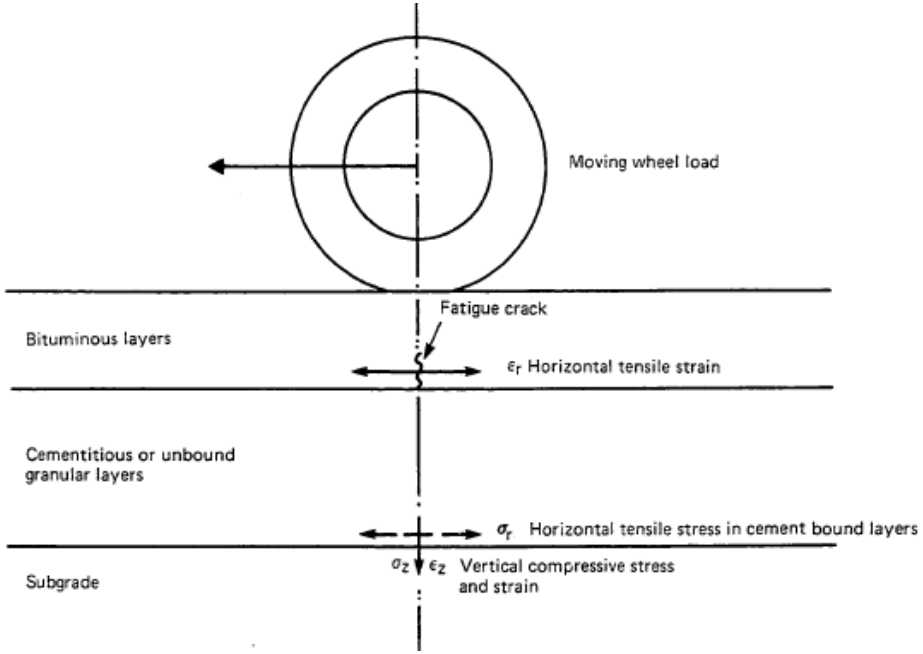
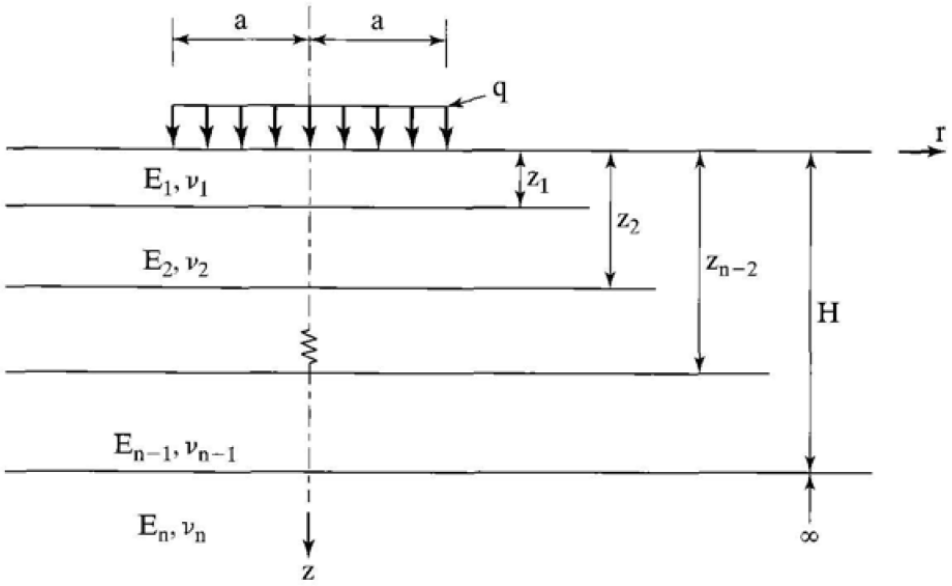


Figure 7.8 Design curves for bitumen bound cold recycled material (Foundation Class 2)





Drivers and context

We published our Net Zero Plan in 2021 to decarbonise the strategic road network

We are taking action in three areas and support delivery of the Government's Transport Decarbonisation Plan.

CORPORATE EMISSIONS

Net zero for our own operations by 2030.

MAINTENANCE & CONSTRUCTION EMISSIONS

Net zero for our maintenance and construction activities by 2040.

ROAD USER EMISSIONS

Net zero carbon travel on our roads by 2050.

national highways

Scope

Support the implementation of circular economy principles and net zero carbon solutions on the trunk road network:

1. Perform desktop study into in situ performance of CRBM
2. Based on results:
   a) Establish new designs for >30 MSA up to ? MSA
   b) Develop design approach for higher stiffness class (Zone B4) material

Site selection

Parameter	Criteria
Installation date	> 10 years
Cumulative traffic	≥ 15 msa (20-year design life) ≥ 30 msa (40-year design life)
Asphalt overlay thickness (mm)	< 150 mm
CRBM type	QVE B3 or B4 only
Foundation condition	N/A – info only

Identification of sites based on:

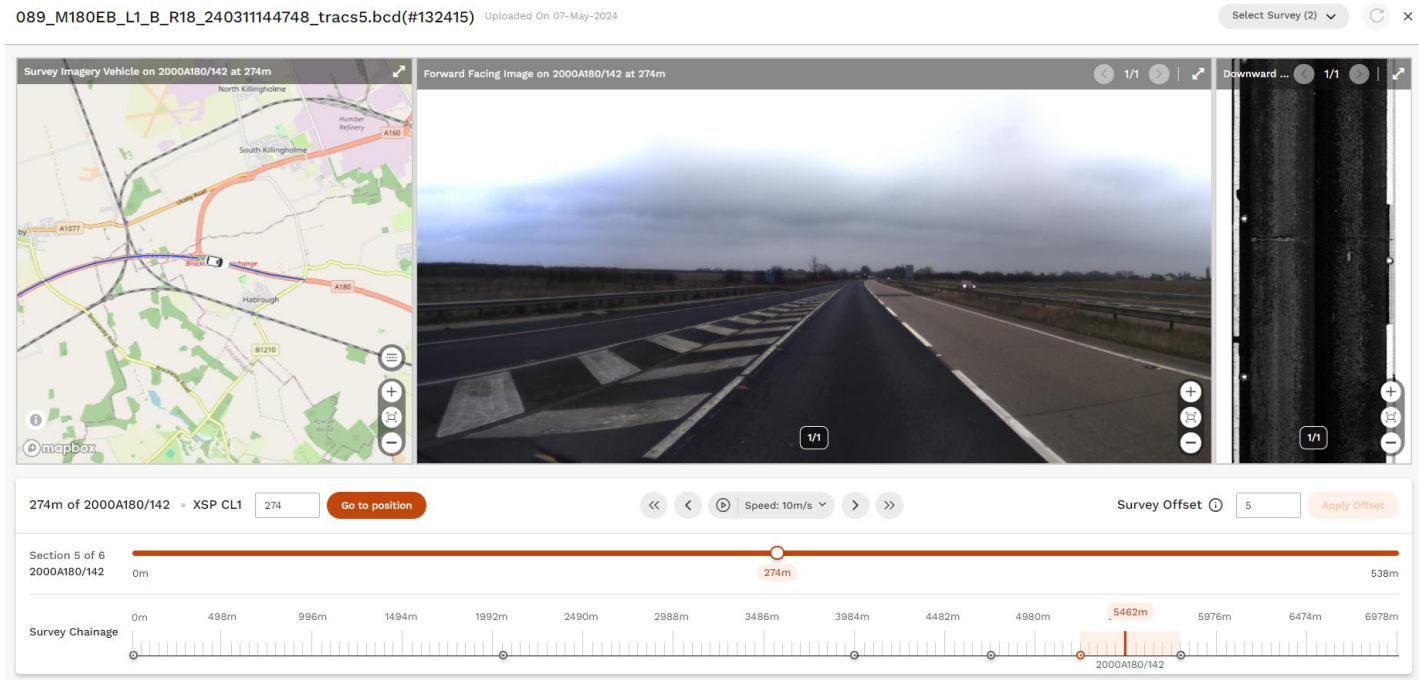
- Pavement management system interrogation
- Local knowledge

5 sites meeting acceptance criteria were identified, totalling 83 llkm

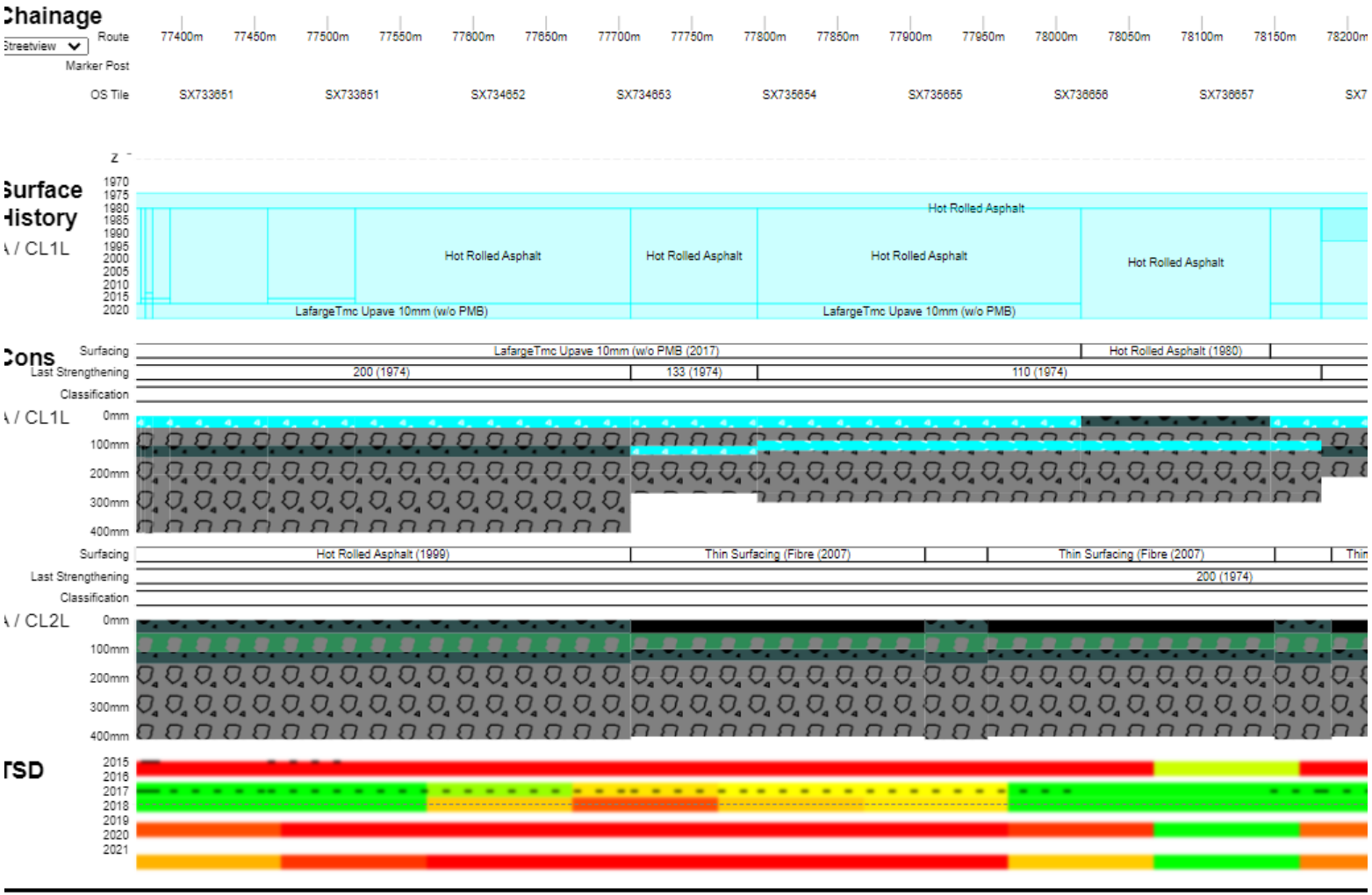
What does ‘satisfactory performance’ look like?

Sites incorporating CRBM were considered to be in satisfactory condition when performance was consistent with other sites of flexible pavement construction in terms of:

- Structural condition
- Ride quality
- Visual condition
- Surface course lifespan

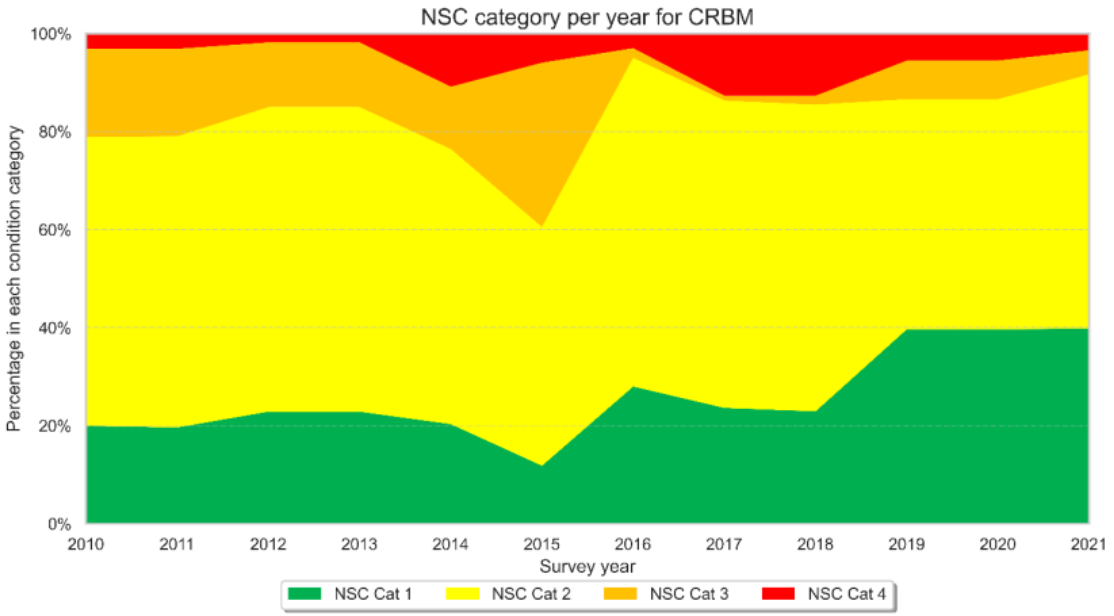


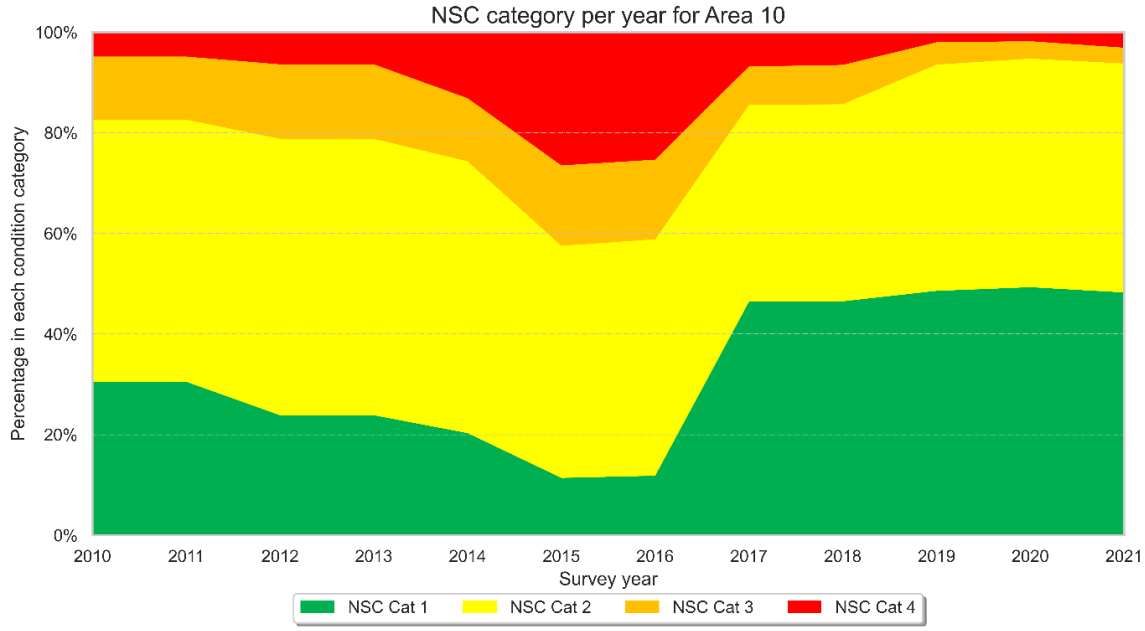
Review of in service performance



Findings - Structural performance benchmarking

Comparison of TSD-derived ‘Network structural condition’ with other flexible pavements.



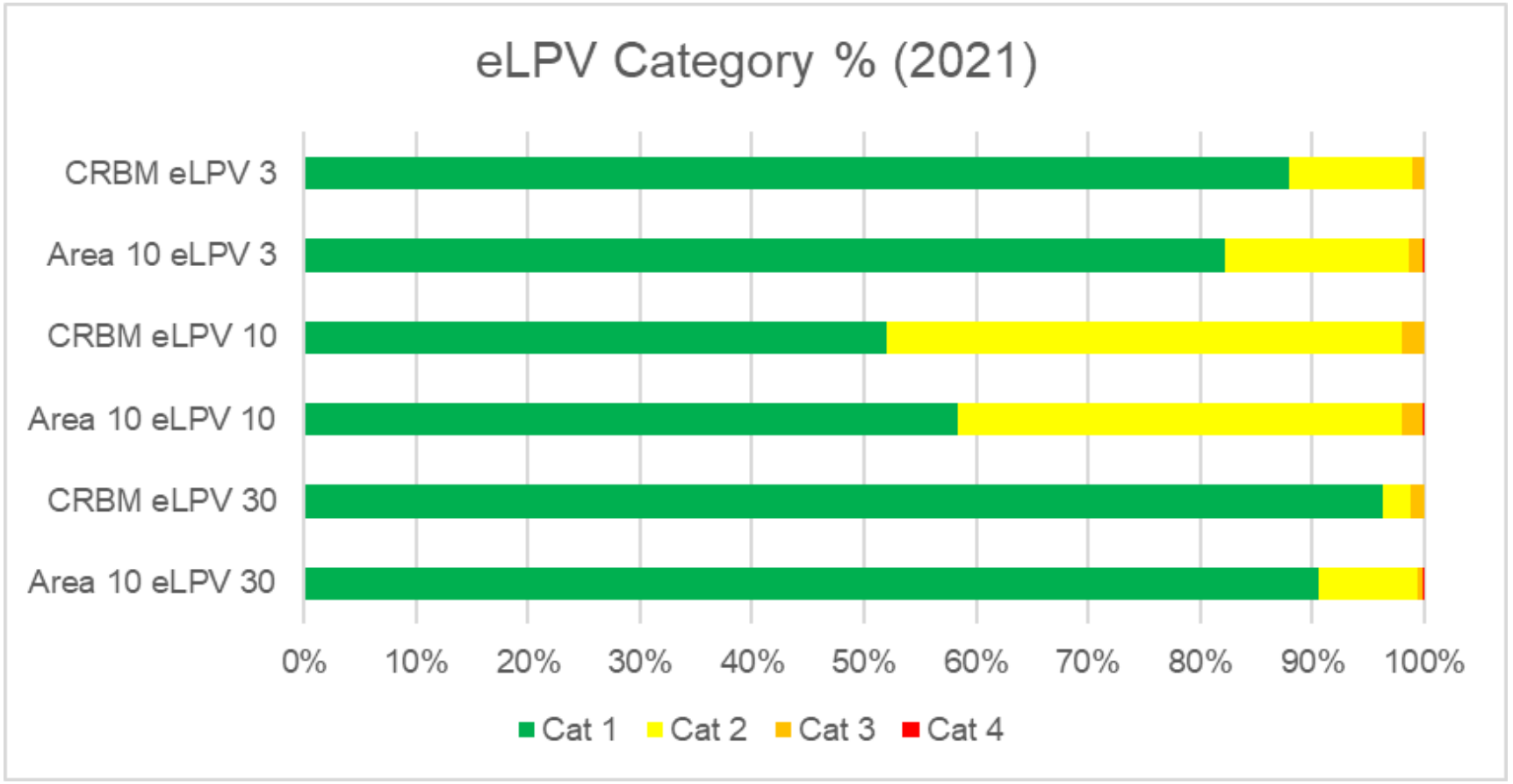


Comparable levels of:

Category 3 – pavement likely to need structural maintenance
Category 4 – pavement very likely to need structural maintenance

Findings – ride quality

Satisfactory performance versus benchmark area of network.



Findings – Surface course history

Site	Age (years)	Traffic (msa)	Number of times lengths of site (%) resurfaced			Avg. surfacing life (years)
			Zero	Once	Twice	
Site 1	20	34	0%	86%	14%	14
Site 2	17	35	0%	50%	50%	8
Site 3	15	32	100%	0%	0%	15
Site 4	13	26	90%	10%	0%	11
Site 5	16	19	100%	0%	0%	16
All CRBM	-	-	29%	48%	23%	11

Comparison with 12 years average surfacing life on trunk road network

Findings and recommendations

Road	Site	Cumulative traffic (msa)	Current indicative CRBM condition	Outline design life expectation (msa) [1]
A21	Sevenoaks	34	‘Satisfactory’ structural condition.	30 msa on bound FC3
A38	Buckfastleigh, Devon	35		80 msa on unbound FC2
A52	Stragglethorpe Rd to Nottingham Rd	32		80 msa on unbound FC2
A46	Stratford upon Avon Northern Bypass	19		<30 msa on bound FC3
A45	Ryton-on-Dunsmore	26	Eastbound carriageway ‘suspect’ structural condition. Westbound ‘satisfactory’ structural condition	80 msa on unbound FC2

Satisfactory performance beyond current design limit.

Existing designs can be extrapolated?

New designs

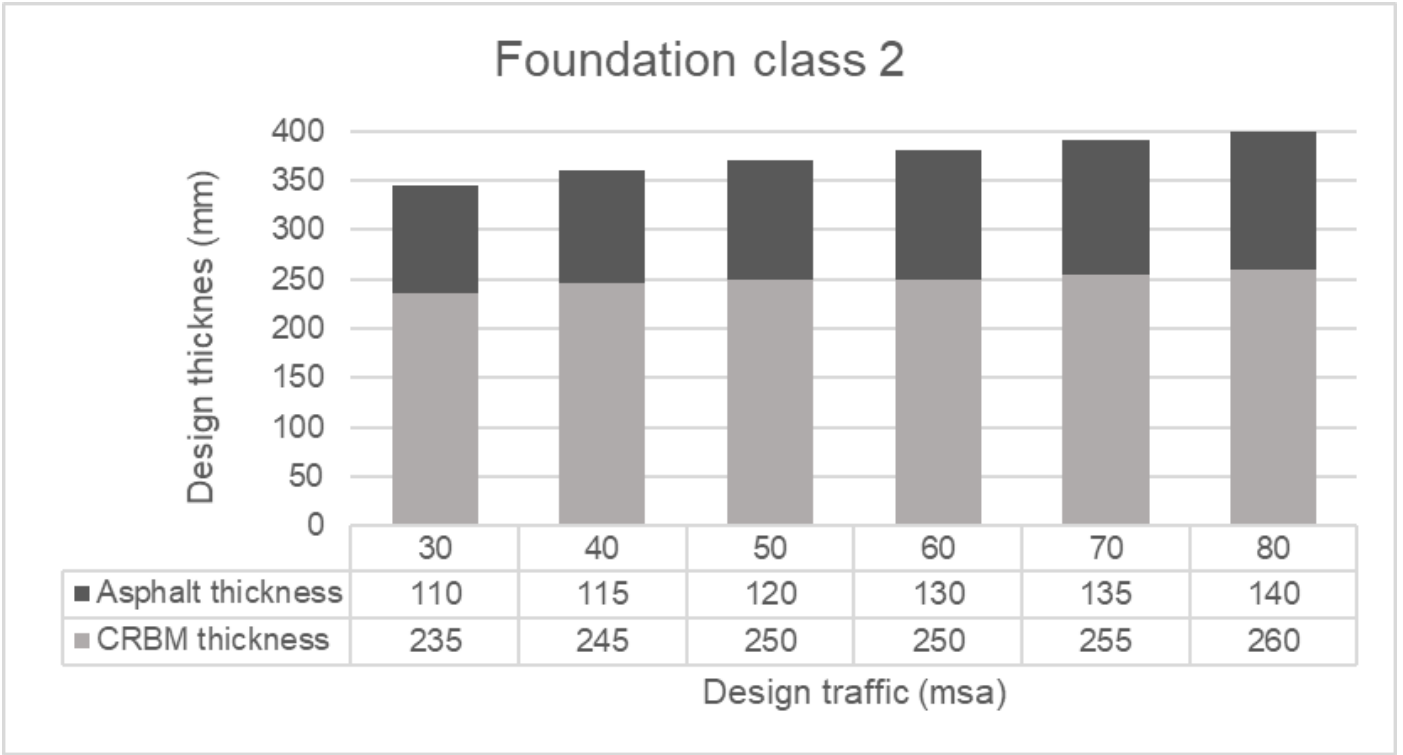
Approx. 40 mm thicker than comparable asphalt designs.

Four-layer construction, two layers of CRBM and two layers of asphalt.

Risk mitigations

- ‘Determinate’ 80 msa design traffic limit
- ‘Lower’ design stiffness (3100 MPa)
- 110 – 140 mm asphalt overlay

Up to 20% cost and 50% carbon reduction versus asphalt construction



Potential future work

- Validation of long-term stiffness with cores and FWD
- Assessment methodology for ‘early trafficking’
- Research into fatigue performance
- Designs for in-line in situ recycling
- Develop in situ performance assessment methodology for CRBM

Thank you.

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