CASE STUDY — RESILIENCE IN HIGHWAYS MAINTENANCE

Thermal Stress Screening: Targeting Highway Inspection During Extreme Heat

Evidence submission — Local Highways Maintenance Transparency Report 2026/27 (Department for Transport)

Authority	Milton Keynes City Council (MKCC) — Highways & Transport
Programme	Climate resilience — heat-event screening of the surfaced carriageway asset to target inspection and mitigation ahead of bitumen bleeding and surface failure
Innovation	MK Thermal Stress Assessment Tool — a physics-based screening model predicting peak pavement surface temperature and comparing it against aged binder softening point and site shear demand, producing a ranked risk register per heat event
Developed by	Arterial Insights consultancy, for MKCC Highways & Transport
Status	Trialled on a sample of the MKCC surfaced carriageway asset register
Model basis	SHRP/Superpave LTPP high pavement temperature relationship at 20mm depth, latitude-corrected to 52.04°N; binder softening points to BS EN 12591, Ring and Ball method BS EN 1427
Validation	Model reproduces the July 2022 Lincolnshire pavement observation — 54 °C measured against 55.7 °C predicted, a conservative over-prediction of 1.7 °C
Transparency link	Climate adaptation and network resilience; preventative rather than reactive maintenance; risk-based inspection and value for money

1. Background and strategic context

Extreme heat is now a recurring operational risk for English highway authorities rather than an exceptional event. When pavement surface temperature approaches or exceeds the softening point of the binder, the asphalt loses stiffness: binder migrates to the surface as bleeding or flushing, aggregate becomes embedded, and under traffic the surface can deform, rut or shove. In severe cases the running surface loses skid resistance and requires emergency sanding, closure or overnight repair.

The operational difficulty is that a heat event arrives with very little notice and affects the whole network simultaneously, while inspection resource is finite. Without a means of ranking risk, an authority is left inspecting either everything superficially or a subjective selection of sites — neither of which is defensible, and neither of which reliably finds the sections that are about to fail.

The Department for Transport's 2026/27 transparency reporting requirements ask authorities to evidence a shift from reactive repair to preventative, risk-based asset management, and to demonstrate how the network is being made resilient. MKCC has trialled a screening tool that converts a weather forecast into a ranked, evidence-based inspection priority across the surfaced carriageway asset — allowing intervention to be planned before the peak rather than in response to a failure.

2. The innovation

The MK Thermal Stress Assessment Tool takes the highway asset register as a CSV export and a forecast air maximum and cloud cover, and returns a risk band and recommended action for every section. It is a single self-contained HTML file that runs locally in a browser with no server infrastructure or IT deployment, so it can be used on any council laptop during an event.

How the model works

For each section the tool calculates an effective thermal margin — how much headroom the surface has before it is at risk — as the aged binder softening point, less the predicted peak surface temperature, less a shear penalty reflecting the loading the site actually experiences. Four components drive the result:

- Peak surface temperature is predicted from forecast air maximum using the SHRP/Superpave LTPP high pavement temperature relationship at 20mm depth, corrected for the Milton Keynes latitude of 52.04°N, with cloud cover suppressing the solar contribution.
- Surface albedo varies with age. A newly laid surface is dark and absorbs strongly (albedo approximately 0.07 in its first year), rising towards 0.18 as it weathers — so new surfaces run materially hotter than old ones under the same air temperature.
- Binder softening point is taken from the specified penetration grade to BS EN 12591 (Ring and Ball, BS EN 1427), then increased for oxidative ageing, which hardens the binder over time. The modelled gain is around 1.4 °C in the first year rising to approximately 11 °C at ten years.
- Shear demand is added as a penalty reflecting where horizontal loading concentrates: 2.5 °C for roundabout circulatory carriageway and bus stops or stands, 2.0 °C for signal approaches, 1.5 °C for gradients over 5%, and nil for straight running. A further penalty of up to 2.0 °C applies where HGV AADT exceeds 1,500.

3. Output: risk bands and operational response

The effective margin is banded and paired with a defined operational response, so the output is an action list rather than a data product:

Risk band	Effective margin	Recommended action
SEVERE	below −6 °C	Pre-emptive inspection before peak. Sand/gritstone pre-positioned. Consider speed or weight restriction; plan overnight repair window.
HIGH	−6 to +2 °C	Inspect within 24 hours of peak. Hold gritstone/sand on standby. Do not divert HGV traffic onto section.
MEDIUM	+2 to +8 °C	Hot-weather watch list. Visual check for bleeding if heat persists three or more days.
LOW	above +8 °C	No action. Normal inspection cycle.

4. The key finding: newest surfaces are most at risk

The most operationally significant output of the trial inverts conventional inspection priority. Two effects compound on a recently laid surface: it is darker and therefore absorbs more solar radiation, and its binder has not yet oxidatively hardened, so its softening point is at its lowest. A newly surfaced section can therefore be several degrees hotter and several degrees weaker than an older section alongside it.

Assessed at a 40 °C clear-sky air maximum — the July 2022 condition — the pattern across sample sections is stark:

Section	Binder	Age (yr)	Peak surface	Softening pt	Effective	Band
Newport Pagnell bus stand	100/150	0.1	57.7 °C	43.3 °C	−16.8	SEVERE
A5 Little Brickhill r'bout	100/150	1.1	57.0 °C	45.9 °C	−15.6	SEVERE
Buckingham Rd, Bletchley	160/220	11.1	55.4 °C	50.3 °C	−5.1	HIGH
A5 Fenny Stratford	40/60	7.1	55.6 °C	62.0 °C	+4.4	MEDIUM
Midsummer Boulevard	PMB	3.1	56.2 °C	71.5 °C	+13.3	LOW

Effective margin in °C. A negative value indicates predicted peak surface temperature plus shear demand exceeds the binder softening point.

A seven-year-old 40/60 surface on a heavily trafficked A-road returns MEDIUM, while a bus stand surfaced in the current year on a lightly trafficked town-centre street returns SEVERE. A conventional heat-event inspection regime, prioritising by traffic volume or by visible existing wear, would very likely have inspected the first and missed the second. The polymer-modified surface on Midsummer Boulevard returns LOW even at 40 °C, quantifying the resilience benefit that specification already delivers.

5. Model provenance, validation and limitations

For a screening tool to be relied upon operationally — and to survive scrutiny afterwards — its provenance and limitations must be explicit. The tool is built on published, citable relationships rather

than bespoke correlation: the SHRP/Superpave LTPP pavement temperature model, and binder softening points to BS EN 12591 determined by the Ring and Ball method of BS EN 1427.

The model has been validated against the July 2022 Lincolnshire pavement temperature observation, where 54 °C was measured and the model predicts 55.7 °C — a 1.7 °C over-prediction, erring in the conservative direction.

Where asset data is incomplete, the tool defaults conservatively and flags every assumption in the output rather than silently defaulting or dropping the section:

- A missing surfacing year is treated as a newly laid surface — the most vulnerable assumption — so the section surfaces as risk and is chased, rather than disappearing from the assessment.
- A missing or unrecognised binder grade is assumed to be 100/150, the softest grade in common modern use.
- An unrecognised site type defaults to straight running, with a flag noting the shear penalty may be understated.
- A missing HGV count is treated as zero, again flagged as potentially understating shear demand.

The tool is explicitly positioned as a screening aid that supplements but never replaces site inspection or Met Office warnings, and a LOW band means the normal inspection cycle applies — not that no inspection is required. Flagged assumptions should be resolved from construction records before the output is relied upon, which in itself drives improvement in asset data quality.

6. How this evidences the transparency report requirements

- Climate adaptation and network resilience — a practical, deployable method for managing a recurring extreme-heat risk to the surfaced asset, converting a forecast into a ranked operational response before the event rather than after it.
- Preventative rather than reactive maintenance — the tool identifies sections at risk of bleeding and surface failure in advance, enabling pre-emptive inspection, pre-positioning of sand or gritstone, and planned overnight repair windows in place of emergency response.
- Risk-based, defensible decision making — inspection priority derives from a documented physical model with published parameters and a stated validation point, so the basis for inspecting one section and not another can be evidenced and reproduced. Every assumption is flagged in the output.
- Value for money — finite inspection resource is directed at the sections where the physical case for failure is strongest, and the tool required no software licence, server infrastructure or IT deployment.
- Asset data quality — the flagging of assumed values generates a prioritised list of asset records requiring resolution from construction records, improving the register with each use.
- Specification learning — quantifying the resilience of polymer-modified and harder-grade binders at heat-vulnerable sites provides an evidence base for future surfacing specification, linking directly to MKCC's wider materials innovation work.

7. Next steps

Following the sample trial, the priorities are to extend assessment across the full surfaced carriageway asset register, resolve the asset records flagged as carrying assumed binder grades and surfacing years, and integrate the screening step into the summer operational routine so that it is run against the forecast ahead of each anticipated heat event. Recording observed outcomes at inspected sections — whether bleeding was found, and at what predicted margin — will allow the risk band thresholds to be calibrated against Milton Keynes conditions over successive summers. The approach is transferable to any authority holding binder grade and surfacing year in its asset register.

Prepared by MKCC Highways & Transport — August 2026. Tool developed by Arterial Insights consultancy. Model references: SHRP/Superpave LTPP high pavement temperature relationship; BS EN 12591 (paving grade bitumens); BS EN 1427 (softening point, Ring and Ball method). Worked figures above are drawn from the sample assessment at

40 °C clear-sky conditions. Supporting evidence (tool, model documentation, assessment outputs and inspection records) is held by the Highways Asset Management Team and available to DfT on request.