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Assessment and Maintenance of Long-Life Flexible Pavements

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Assessment and Maintenance of Long-Life Flexible Pavements

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• Background
• Assessment of the network
• Maintenance and upgrading existing roads
• What else do we need to know?
UK

2.5% area of USA

25% of the population

~ 10 times population density
Trunk Road Network in England
Industry Deliverables

Reliability = long life pavements, quality and a skilled workforce
Overview of Current UK M-E Design Method

- 1984: Conventional approach – Limit strains at critical locations
- 1997: Review lead to Long-Life (Perpetual) pavements
- 2005: Adapted to include a greater range of pavements
- 2006+: Design concepts currently being re-examined
Structural Deformation

Rate of rutting (mm/msa) vs. Thickness of bituminous layer (mm)

Data from in-service pavements
Structural Deformation

Rate of rutting (mm/msa) vs. Thickness of bituminous layer (mm)

Interpretation at the time (1984)
Structural Deformation

Rate of rutting (mm/msa)

Long-life interpretation

Thickness of bituminous layer (mm)
“A Long-life Pavement is a type of pavement that can be identified as one lacking any deterioration in either the foundation or the structural pavement layers. Any distresses that might occur are confined to the surfacing layers only.”

ELLPAG (European Long-Life Pavement Group) - Phase 1 Report
RENEWING 20 YEAR OLD SURFACE
RENEWING 40 YEAR OLD SURFACE
CHANGE IN BITUMINOUS STIFFNESS OVER TIME

![Graph showing the change in bituminous stiffness over time. The x-axis represents age in years, ranging from 0 to 40, and the y-axis represents stiffness in GPa, ranging from 0 to 10. The data points are scattered across the graph, indicating variability in stiffness with age.]
DEFLECTION HISTORIES OF IN-SERVICE MOTORWAYS (DEFLECTOGRAPH)
Evolved Long-Life Pavements

- Existing pavements
- Well constructed
- Curing effect of asphalt materials
- Pavement responses reduce, extending the life of the pavement
- Pavement responses below the threshold
- Long-life pavement
Three routes to long-life.....

• Create a long-life pavement → TRL 250

• Build a pavement that eventually becomes a long-life pavement → Assessment

• Perform some structural improvement of an existing pavement → Upgrading
Identifying LLP’s on the network

- Deflection – Thickness approach
- Originally network and scheme level
- Now Scheme level
- Uses Deflectograph
Original deflection-thickness chart

Asphalt Thickness

Deflection

Increasing likelihood of being a LLP

- 0%
- 50%
- 90%
Structural Assessment - DMRB

Preliminary pavement classification

Determinate life pavements

Upgradeable to LLP

Long-life pavements

Total Thickness of Bituminous Material (mm)

Standard Deflection (mm)
Current Upgrading

- Upgradeable
- Add overlay
- Long-life pavement

Graph showing the relationship between Total Thickness of Bituminous Material (mm) and Standard Deflection (mm). The graph indicates areas for upgradeable, add overlay, and long-life pavement conditions.
Current Upgrading

- Pavements classified as Upgradeable LLP
- Overlay to bring asphalt thickness to greater than 300mm
- Algorithms built into HAPMS CONFIRM
Other pavement classifications

At present three pavement classifications

- Long-life pavements
- Upgradeable LLP’s
- Determinate life pavements
Other pavement classifications

Long-life pavements are particular types of pavements with

• Low deflections
• Strong foundations
• Thick asphalt layers
• No structural deterioration

What if asphalt layers not so thick?
What if deflections not so low?
Other evidence in TRL Report 250

- Deformation confined to asphalt layers for pavements greater than 180mm
- Surface cracking confined to 100mm depth for pavements greater than 160mm

Therefore expect well constructed pavements greater than 200mm thick to have long-life characteristics
Other pavement classifications

- Why 300mm threshold for thickness?
- Why particular threshold for deflection?

**RISK**

- Risk of failure requiring early intervention
  - For high volume roads: low risk
  - For lower traffic volumes: a greater risk may be justified
Original deflection-thickness chart

Deflection

Asphalt Thickness

Increasing likelihood of being a LLP

0%
50%
90%
Cautious classifications i.e. Low risk

Determinate life pavements

Long-life pavements

Upgradeable to LLP
Introducing Robust Pavements

![Graph showing the relationship between Standard Deflection and Total Thickness of Bituminous Material, indicating Low risk and Medium risk areas. The graph highlights Robust or Determinate life pavements and Long-life pavements.](image-url)
A robust flexible pavement:

- asphalt of at least 200mm
- no structural deterioration under current traffic level
- good quality foundation
- needs regular structural assessment
- probably needs maintaining like a long-life pavement
Identifying Robust Pavements

• No structural damage
• Sound asphalt
• Adequate foundation
• Adequate asphalt thickness
• Maintenance history
Identifying Robust Pavements

- **No structural damage**
  - Deflection trends
  - Maintenance history

- **Sound asphalt**
  - Inspection of cores

- **Adequate foundation**
  - Direct and indirect measurement of modulus

- **Adequate asphalt thickness**
  - Cores or ground penetrating radar
No structural damage?

- Pavement responses
No structural damage

- Evolution of pavement responses – deflection trends
Foundation stiffness
Following identification of RP

Either:

- Medium risk strategy
- Treat as LLP with more careful structural monitoring

Or

- Low risk strategy
- Upgrade to low risk LLP
Upgrading of Robust Pavements

- **Low risk**: Robust or Determinate life pavements
- **Medium risk**: Robust or Upgradeable to LLP

**Graph Details**:
- **Y-axis**: Standard Deflection (mm)
- **X-axis**: Total Thickness of Bituminous Material (mm)
- **Legend**:
  - Green circle: Low risk
  - Red circle: Medium risk

**Regions**:
- **Robust or Determinate life pavements**: Low risk
- **Long-life pavements**: Medium risk
- **Robust or Upgradeable to LLP**: Medium risk

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The graph illustrates the upgrading of robust pavements based on standard deflection and total thickness of bituminous material. The risk levels are indicated by different colored circles and the shaded areas represent the thickness ranges for each category.
Current Upgrading

- Upgradeable
- Add overlay
- Long-life pavement

Graph showing the relationship between Standard Deflection (mm) and Total Thickness of Bituminous Material (mm).
Robust Upgrading

- Robust Upgrading
- Total Thickness of Bituminous Material (mm)
- Standard Deflection (mm)
- Upgradeable to LLP
- LLP
- DLP
Upgrading robust pavements

- Thickness deficiency (110mm)
- Overlay (50 + 110mm)

Graph showing:
- Standard deflection (mm) on the y-axis
- TTBM (mm) on the x-axis
- Robust pavement transition

Legend:
- TTBM (mm) range: 0 to 500
- Standard deflection range: 0 to 0.5
Upgrading robust pavements
Robust Upgrading?

Not needed?

- Total Thickness of Bituminous Material (mm)
- Standard Deflection (mm)

Upgradeable to LLP
DLP
LLP

0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35
0 100 200 300 400 500 600 700 800 900 1000
Potential impact of RP’s on HA network?

![Graph showing the relationship between total thickness of bituminous material and standard deflection. The graph indicates various percentages such as 1%, 9%, 20%, 20%, 50%, and 9%. The x-axis represents the total thickness of bituminous material in mm, ranging from 0 to 1000, while the y-axis represents standard deflection in mm, ranging from 0.00 to 0.36.]
DMRB advice

Sub-base
Binder Course
Surface Course

Existing Pavement
Overlay
Thin overlay
Inlay
Resurfacing
Patch

New Surface Materials
Existing Materials
Pavement Deterioration:

Wheelpath Deterioration
Proposed alternative treatments

- Sub-base
- Base
- New Binder
- Binder Course
- New Surface
- Surface Course

Trench Inlay in Wheel Path
Alternative treatments

Existing Cracked Pavement

Inlay

Partial Depth Inlay

Surface Course

Binder Course

Base

Sub-base

New Surface Materials
Existing Materials
Benefits of this work

• More of the network identified as potentially long life or robust, particularly on the non-trunk roads

• More options for upgrading

Therefore

• More efficient use of materials

• Better value

• Safer and less disruptive maintenance
Developments

- Dynamic deflections at traffic speed
- Crack detection
- High modulus binder course
- Improved durability
- Re-examine pavement performance and feed-back into design
In the UK we now have……

HA's
Traffic Speed Deflectometer
Traffic Speed Deflectometer (TSD)
TRL track testing – SRS

Slope Vs. Chainage
Sections 1, 2 & 3 averages plus 100 pt moving average

Chainage [m]

Slope [mm/m]

Deflection [mm]
How to assess crack depths?

Use slow-speed ground penetrating radar

Coring?

![Image of slow-speed ground penetrating radar]

GPR measurements with water (M4)

Best-fit (plotted with all points, excluding water measurements) Linear one-to-one (x = y)

$y = 0.9771x + 3.457$

$R^2 = 0.8499$
High Modulus Materials

- Enrobé à Module Elevé (EME)
  - High binder content/ low air voids
  - Very stiff binder
  - a good track record
  - a laboratory design procedure
EME: resistance to deformation

Minimal deformation in the EME
Re-examine pavement performance and design concepts

- Very complex system
- Understand deterioration phenomenon
- Observe of what is happening
- Re-examine basic concepts
Observations suggest that with a reasonable asphalt thickness, fatigue and structural deformation are not an issue.

What happens in thinner pavements?

Is cracking something waiting to happen as the pavement age hardens?
Benefits of this work

- More efficient use of resources
- Better value
- Safer and less disruptive maintenance

Perpetual or LLPs are durable and ‘resource efficient’
Thank you for listening
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