The European Approach to Long Lasting Asphalt Pavements: A state-of-the-art review by ELLPAG

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European Long-life Pavement Group
ELLPAG

is a **FEHRL** Working Group

(Forum of European National Highway Research Laboratories)

with support from **CEDR**

(Conference of European Directors of Roads)
Core Membership
11 countries

[Map showing the 11 countries of the Core Membership with their respective flags and acronyms: TRL, LCPC, NTUA, KTI, DWW, RBI, ISTU, DRI, LAVOC, BRRC, IMI]
Four main aims of ELLPAG

With respect to long-life pavements:

• to determine best designs
• to determine economic benefits
• to understand deterioration mechanisms
• to encourage their use

With a particular emphasis on the needs of the structural support layers
Main aims of the Group - 1

- To determine the best methods and optimum strategy for designing, constructing, assessing and maintaining pavements without structural deterioration i.e. 'long-life' pavements
Main aims of the Group - 2

- To better understand the economic benefits of correctly constructed and maintained 'long-life' pavements

i.e. sustainable pavements?
Main aims of the Group - 3

- To better understand the deterioration mechanisms of pavements and thus how to classify pavements, in particular those known as 'long-life' pavements.
Main aims of the Group - 4

- To encourage the use of 'long-life' pavement design and maintenance wherever appropriate
Objective - Short Term

- A State-of-the-art Review of current European knowledge on the design and maintenance of fully flexible pavements, with emphasis on the structural layers
Objective - Medium Term

- To produce similar State-of-the-art Reviews for the other common pavement types.
Objective - Long Term

- A user-friendly Best Practice Guidance note on long life pavement design and maintenance for all the common types of pavement construction used in Europe.
Plan for the flow of the work of ELLPAG

Phase 1: Review of Fully Flexible LLPs
Phase 2: Review of Semi-Rigid LLPs
Phase 3: Review of Rigid LLPs
Phase 4: Production of Best Practice Guide

Identify Knowledge Gaps

TIME

Research
Tasks carried out in Phase 1

- Technical Management
- Definition of Long-Life Pavements
- New Pavements
- Assessment and Upgrading
- Maintenance
- Economics
- Knowledge Gaps
- Production of the Final Report
CONTENTS
Definition
Design and construction
Assessment
Maintenance
Economic analysis
Research needs
Recommendations
Definition

- A Long-life Pavement is a type of pavement where no significant deterioration will develop in the foundations or the road base layers provided that correct surface maintenance is carried out.
What does this mean?

- There is much evidence for
  - Top down cracking only
  - Deformation only in surfacing

- If the pavement is sufficiently strong and well built
Why do we need long-life pavements?
FLEXIBLE PAVEMENT CONSTRUCTION

- WEARING COURSE
- BASECOURSE
- ROADBASE
- FORMATION
- SUB-BASE
- SUB-FORMATION
- CAPPING
- SUBGRADE
- FOUNDATION
- BITUMINOUS BOUND LAYERS
DESIGN CHART
(INCREASING THICKNESS)

Cumulative traffic (msa)

0.01 0.1 1 10 100 1000

Future requirement
Current traffic limit
Experimental pavements
Extrapolation

Thickness of bound layer (mm)

0 100 200 300 400 500 600

0 0.01 0.1 1 10 100 1000

Cumulative traffic (msa)

ELLPG
SURFACE RUTTING

WHEEL LOAD

BITUMINOUS LAYER

GRANULAR SUB-BASE

SUBGRADE
FATIGUE CRACKING

WHEEL LOAD

Crack (bottom of roadbase)

TENSILE STRAIN
SURFACE CRACKING

WHEEL LOAD

Crack
(surface initiated)
CORE THROUGH CRACK
DEFLECTION HISTORIES OF IN-SERVICE MOTORWAYS (DEFLECTOGRAPH)

- Cumulative standard axles (millions)
- Standard deflection (mm)

Graph showing deflection histories with two curves:
- Investigatory Level
- Conventional Life Curve

Axes:
- Y-axis: Standard deflection (mm)
- X-axis: Cumulative standard axles (millions)
DESIGN CURVES FOR ASPHALT PAVEMENTS

Design life (msa)

Thickness of asphalt layers (mm)

DBM

DBM50

HDM

ELLPAG
Review of European Designs

Stated Nominal Design Periods

- 20 years
- 30 years
- Not Stated
- 15 years
Review of European Designs

Asphalt design thicknesses for 100msa_{80} design traffic
Review of European Designs

Design periods in use

10 years

20 years

30 years

40 years

More than 40 years
Example Pavement Designs

The diagram illustrates the thickness of pavement designs for different countries, categorized into Long-Life Designs and Heavily Trafficked Designs. Each bar represents the thickness (mm) of the pavement layers, with separate sections for the Surface course, Binder course, and Base.

Countries included in the diagram are UK, USA, Germany, Denmark, Finland, Norway, Poland, Italy, Sweden, Hungary, Austria, Switzerland, Netherlands, Greece, Belgium, and France.
Economic benefits

- Comparison of
  - Traditional pavement design
  Vs
  - Long-life designs

Should not generalise for every design need to consider:
For every design need to consider:

- Initial cost
- Deterioration cost
- Effects of road works
  - User delay costs
  - Accident costs
- Environmental costs
- Agency costs
  - Treatment costs
  - Traffic management costs
Several Cost Benefit Analysis models available for the economic assessment of LLP’s

- E.g.
  - Current UK model
  - OECD project model PASI (Project Analysis System International)
  - Model being developed within FORMAT project

None yet takes full account of all the necessary parameters however:
Sample network economic analysis

Considering a core network of 10,000 km over a 10 year period

- For new pavements, use of llp designs could save
  - €50M in construction costs
  - €70M in maintenance costs
- For maintenance of existing network, use of llp approach could save
  - €110M in maintenance works costs
  - €100M+ in road user costs
- + sustainability benefits
But

- What proportion of existing pavements already LLPs?
- Are LLPS universally applicable?
- Do we fully understand the deterioration mechanisms of LLP’s?
No!

- Therefore we need to investigate further through cooperative European research, for example to discover:
  - How asphalt material properties relate to long-life behaviour
  - What is the optimum maintenance strategy for long-life pavements
  - How we can fully assess the economic benefits of LLP’s

The benefits of such a programme would be ENORMOUS
Are they economic solutions?

Considering the management of a heavily trafficked core network of 10,000 km over a 10 year period the use of long-life designs can give a total saving of well over €300M.
Two questions?

- Why are more countries not using long-life designs?
- Why is there not more research into long-life designs?
Complex 3-D contact stress condition

Area of Interest:
Footprint of a tire when in contact with the pavement surface
Model the tyre/pavement system

- Four stages of loading:
  - Inflate the wheel to the required pressure
  - Lower the wheel to the pavement surface
  - Apply the wheel load
  - Apply the wheel velocity

Modelling of the wheel
Half wheel model

Half of the wheel is used

Deformed wheel
Strain induced by a rolling wheel: Visco-elastoplastic pavement model
SURFACE CRACKING

Excessive ageing at surface

Thermal Effects

Traffic stresses
Load Associated Surface Cracking

Horizontal Tensile Strain (Zoom View)

Tyre edge
Stress distribution, cracked pavement
Likelihood of Pavement being Long-life

Deflection

Bituminous Thickness

Increasing likelihood of being LLP
Thank you for listening!