HMA Fatigue in FAARFIELD

- FAARFIELD is a computer program for airport pavement thickness design. FAA AC 150/5320-6F.

- Old HMA Fatigue Model: Heukelom & Klomp [1962]
  \[ \log_{10}(C) = 2.68 - 5 \times \log_{10}(\varepsilon_h) - 2.665 \times \log_{10}(E_A) \]
AASHTO T321-14, Standard Method of Test for Determining the Fatigue Life of Compacted Asphalt Mixtures Subjected to Repeated Flexural Bending
AN ENERGY APPROACH FOR AIRPORT PAVEMENT
LOW DAMAGE FATIGUE BEHAVIOR

Fatigue data line of equality

Predicted Nf using Simplified RDEC

Measured fatigue life, Nf

By:
Shihui Shen and Samuel H. Carpenter
Civil and Environmental Engineering Department
University of Illinois at Urbana-Champaign
Urbana, IL 61802
USA
Phone: (217) 244-8064, Fax: (217) 333-1924
sshen2@uiuc.edu
scarpent@uiuc.edu
AN ENERGY APPROACH FOR AIRPORT PAVEMENT
LOW DAMAGE FATIGUE BEHAVIOR

By:
Shihui Shen and Samuel H. Carpenter
Civil and Environmental Engineering Department
University of Illinois at Urbana-Champaign
Urbana, IL 61802
USA
Phone: (217) 244-6064; Fax: (217) 333-1624
sshen2@uiuc.edu
scarpent@uiuc.edu
HMA Fatigue in FAARFIELD


\[ N_f = 0.4801 \times PV^{-0.9007} \]

\[ PV = 44.422 \times \varepsilon_h^{5.14} \times S^{2.993} \times VP^{1.85} \times GP^{-0.4063} \]

where PV is the estimated value of RDEC plateau value (dimensionless),
S is HMA flexural stiffness (psi),
\( \varepsilon_h \) is horizontal strain at the bottom of the asphalt layer,
VP is the volumetric parameter, and
GP is gradation parameter.

(AASHTO T321-14, Standard Method of Test for Determining the Fatigue Life of Compacted Asphalt Mixtures Subjected to Repeated Flexural Bending)
HMA Fatigue in FAARFIELD

\[ VP = \frac{V_a}{V_a + V_b} \]
\[ GP = \frac{(P_{NMS} - P_{PCS})}{P_{200}} \]

where
- \( V_a \) is air voids,
- \( V_b \) is asphalt content by volume,
- \( P_{NMS} \) is the % of aggregate passing the nominal maximum size sieve,
- \( P_{PCS} \) is the % of aggregate passing the primary control sieve, and
- \( P_{200} \) is the % of aggregate passing the #200 (0.075 mm) sieve.
CC7 – Perpetual Pavements

![Graph showing FAARFIELD Predicted Passes to Failure vs. Tensile Strain at Bottom of P-401]
Pavement Cross Sections

LFP-1N
15 inch
34 inch
LFP-2N
12 inch
37 inch
LFP-3N
10 inch
39 inch
LFP-4N
8 inch
LFC-5N
5 inch
8 inch
LFS-6N
41 inch
29 inch
29 inch

P401 HMA SURFACE
DRAINABLE BASE
P154 SUBBASE
P209 CRUSHED STONE BASE
SUBGRADE (CBR 5-6)
Traffic Tests

- Standard NAPTF wander pattern.

- 55 kips (245 kN) wheel load
- 6-wheel gear.
Crack Monitoring

![Crack Monitoring Graph]

- LFP1-N
- LFP2-N
- LFP3-N
- LFP4-N
- LFC5-N
- LFS6-N

Crack Area, Square Feet

Passes
## Predicted & Observed Fatigue Life

<table>
<thead>
<tr>
<th>Test Section</th>
<th>HMA Strain (from FAARFIELD)</th>
<th>PV</th>
<th>Pass to Coverage (P/C) Ratio</th>
<th>( N_i ) from FAARFIELD Passes</th>
<th>( N_i ) from FAARFIELD Coverages</th>
<th>( N_i ) from Full-Scale APT Passes</th>
<th>( N_i ) from Full-Scale APT Coverages</th>
<th>( \frac{N_i}{N_{FAARFIELD}} )</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP-1</td>
<td>0.000524</td>
<td>2.14E-06</td>
<td>0.650</td>
<td>40000</td>
<td>61538</td>
<td>NO CRACKS OBSERVED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP-2</td>
<td>0.000657</td>
<td>6.86E-06</td>
<td>0.730</td>
<td>15385</td>
<td>21075</td>
<td>NO CRACKS OBSERVED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP-3</td>
<td>0.000781</td>
<td>1.67E-05</td>
<td>0.790</td>
<td>7407</td>
<td>9376</td>
<td>21450</td>
<td>27152</td>
<td>2.90</td>
<td></td>
</tr>
<tr>
<td>PP-4</td>
<td>0.000932</td>
<td>4.14E-05</td>
<td>0.860</td>
<td>3636</td>
<td>4228</td>
<td>11814</td>
<td>13737</td>
<td>3.25</td>
<td></td>
</tr>
</tbody>
</table>