Do You Believe Curvature?

A Review of the AUSTOADS Overlay Design Procedures

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Austroads Rehab Guide 2004

- Chart based procedures for thickness design of asphalt overlays
- Chart for permanent deformation based on deflection \( (d0) \)
- Chart for asphalt fatigue based on curvature \( (d0-d200) \)
- The latter relates required asphalt overlay from measured curvature to design traffic
Characteristic curvature = D0-D200
Figure A6.2.2  Asphalt overlay fatigue lives WMA PTrs 20–25°C
Asphalt Fatigue Charts

• Developed using mechanistic modelling
• Basically CIRCLY was used to model a range of different pavement configurations and varying asphalt overlay depths
• Allowable traffic loading calculated for each pavement configuration and the also the predicted FWD curvature
CIRCLY Curvature

- FWD curvatures calculated using plate-pavement contact stress = 566 KPa, radius = 150mm
- Assumes a uniform stress distribution
- Is this realistic?
Actual Deflection Bowls

Note how the change in curvature around 200 – 300mm
Consider the Following Example

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>Measured Deflection (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.16</td>
</tr>
<tr>
<td>200</td>
<td>1.68</td>
</tr>
<tr>
<td>300</td>
<td>1.34</td>
</tr>
<tr>
<td>450</td>
<td>0.94</td>
</tr>
<tr>
<td>600</td>
<td>0.66</td>
</tr>
<tr>
<td>750</td>
<td>0.47</td>
</tr>
<tr>
<td>900</td>
<td>0.35</td>
</tr>
<tr>
<td>1200</td>
<td>0.23</td>
</tr>
<tr>
<td>d0-d200</td>
<td>0.47</td>
</tr>
</tbody>
</table>
3 Trial Pavement Models

1. Assume uniform stress distribution and solve for \( d_0 = 2.16 \text{mm} \)
2. Assume uniform stress distribution and solve for \( d_0 - d_{200} = 0.47 \text{mm} \)
3. Assume non-uniform stress distribution and solve for both \( d_0 - d_{200} \) and \( d_0 \)
Trial 1

40 KN, $P_1 = 566$ kPa, $r = 150$ mm, $q = 0.0$

300 mm Granular 400 MPa, $v = 0.35$

3,500 mm Subgrade 27 MPa, $v = 0.45$

10,000 MPa (to account for non-linearity in subgrade)
Trial 2

40 KN, $P_1 = 566$ KPa, $r = 150$ mm, $q = 0.0$

300mm Granular 400 MPa, $v = 0.35$,

3,500mm Subgrade 52 MPa, $v = 0.45$

10,000 MPa (to account for non-linearity in subgrade)
Trial 3

40 KN, $P_1 = 198$ KPa, $r = 150$mm, $q = -0.65$

300mm Granular 400 MPa, $v = 0.35$

3,500mm Subgrade 24 MPa, $v = 0.45$

10,000 MPa (to account for non-linearity in subgrade)
Comparison of Circly models

-2.50
-2.00
-1.50
-1.00
-0.50
0.00

-1500 -1000 -500 0 500 1000 1500
distance from load centre
deflection

Trial 3 Trial 1 Measured FWD Bowl Trial 2

d0-d200 = 0.47
d0-d200 = 0.65
d0-d200 = 0.47
• Demonstrated that significant error can be introduced into the pavement analysis process if measured deflections are obtained with anything but a uniform distribution

• Used stress sensitive film between load plate and pavement surface to assess stress distribution

• Found that in weak pavements contact pressure is not uniform

• Volcanic pavements are ‘weak’ by this definition
Stress Sensitive Film

Smooth newly paved asphalt

Weak pavement asphalt surfaced
Conclusion

• Austroads 2004 overlay design procedures may be not be valid in highly deflective pavements
• Advanced loading features in CIRCLY can be used to vary stress distribution to obtain a closer bowl match
Other considerations

- A counter balance is the Austroads fatigue criterion may be overly conservative
- Graphical procedures based on characteristic (mean) curvature for the section
- In highly deflective pavements can be impossible to characterise sections (c.o.v < 25%)