Adaptation of the Austroads Pavement Design Guide for New Zealand Conditions

- Transfund Research Project 906

The basis of the project is that granular pavement design is currently based on the assumption that all deformation of the pavement shape under traffic loading occurs in the subgrade. To reflect this the Austroads Pavement Design Guide is based on limiting the vertical strain on the subgrade. Observations on CAPTIF and in the field show that significant deformation occurs also in the granular base layers, and that design based solely on subgrade strain criteria does not reflect observed pavement performance.
In both Australia and New Zealand, pavements designed using figure 8.4 and measured subgrade California Bearing Ratio (CBR) generally achieve their design life

- New Zealand supplement
Rehabilitation according to AUSTROADS criterion generally achieve the intended reductions in subgrade strain.

The New Zealand application of AUSTROADS

- Are the conditions that were used to produce figure 8.4 in AUSTROADS applicable in New Zealand?
- Are AUSTROADS strain criterion appropriate in New Zealand?
- Where, if at all, might it be necessary to adapt AUSTROADS?
Can we trust the results?

“Designers must be aware that in spite of the pseudo scientific approach of all modern pavement design methods, there is at the heart a very empirical relationship of doubtful legitimacy.”

Unbound Granular Material

- Unbound granular material (UGM) can not support tensile strain, but linear elastic analysis predicts tensile strains in UGM.

- Optimum compaction appears to be 95% of the maximum dry density.
Not all the permanent strain occurs in the subgrade, rutting within the aggregate layer is an important element of the overall distress
  • Andrew Dawson Workshop (2002)

Repeated Load Triaxial testing has established a NZ protocol to distinguish between materials
Back analysis of the deflection bowl generated by a Falling Weight Deflectometer (FWD) may be used to estimate the elastic properties of the *in situ* pavement materials.

- Tonkin & Taylor Ltd. (1998). Pavement deflection measurement and interpretation for the design of rehabilitation treatments. Transfund Report No. 117
Subgrade Modulus varies with Stress

- The variation of the modulus with stress strongly influences the strain but has little influence on the stress distribution
  - Per Ullidtz
- Volcanic soils have various relationships between California Bearing Ratio (CBR) and modulus

- Use different strain criteria for different subgrades by scaling up the Austroads criteria
  - Salt
Subgrade Strain and Fatigue

- Subgrade strain criteria for volcanic soils may be conservative by at least a factor of 1.5

- Stabilized subgrade can be relied on in the long term
Subgrade Modulus

- There is little relationship between subgrade modulus and the accumulation of plastic strain in volcanic soils

“The non linearity of most subgrade soils and unbound aggregate makes the determination of the elastic modulus somewhat of a moving target”

The fourth power law; for both compaction and wear mechanisms within pavements the design traffic is proportional to the load to the power of approximately two rather than four.

The influence of seasonal effects are still predominately unknown.


Few clear relationships between measured parameters.

Fatigue Behaviour

- The asphalt fatigue mechanism of AUSTROADS is not applicable on thick asphalt cement pavements.

- There is limited information on the rest period and associated self healing properties of pavements
As early as 1993 shakedown theory was proposed as a possible mechanism to describe pavement deformation.

In NZ the reconstruction of pavements is driven by factors other than structural deterioration. Many of these pavements have significant life according to AUSTROADS.

Rutting and roughness are not generally the reasons for reconstruction.

# HDM Roughness

<table>
<thead>
<tr>
<th>Design ESA</th>
<th>Subgrade CBR</th>
<th>Total granular thickness (mm)</th>
<th>SNC</th>
<th>Terminal Roughness (NAASRA)</th>
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<td>5</td>
<td>490</td>
<td>3.71</td>
<td>210.1</td>
</tr>
</tbody>
</table>
Papers Examined

- Tonkin & Taylor Ltd. 1998. Pavement deflection measurement and interpretation for the design of rehabilitation treatments. Transfund Research Report No 117


de Pont, Steven, & Pidwerbestky. 1999. The relationship between dynamic wheel loads and road wear. Transfund Research Report No 144


Papers Examined cont.

- de Pont, Steven, Alabaster, & Fussell. 2001. Effect on pavement wear of and increase in mass limits for heavy vehicles. Transfund Research Report No 207
- de Pont, Steven, Alabaster, & Fussell. 2003. Effect on pavement wear of an increase in mass limits for heavy vehicles-Stage 2. Transfund Research Report No 231
Opus:

an accomplished work,

a creation,

an achievement

Central Laboratories
South African approach

- Final selection of pavement design is based on the life cycle costs.
- Essentially a critical layer approach
- Still utilizes linear elastic multilayer analysis but incorporates pavement performance models also.
Some questions

- What does a failed road look like?
- What, of the myriad possible, are the important failure mechanisms?
The New Zealand application of AUSTROADS

- Why is the plastic strain linked with the resilient strain?
  - The resilient modulus is not closely related to permanent deformation (Andrew Dawson workshop, 2002)
Given uncoupling of plastic and elastic pavement deformation is it reasonable to assume a relationship between elastic strain and life of pavement?
Is the concept of an Equivalent Standard Axle still necessary given modern computer capabilities?
What application can we make of Highway Design and Maintenance Standards (HDM) models?

Does the use of HDM models improve the situation?

Do the South African models have anything to add to the New Zealand situation?