Mechanistic Design of Pavements on Weak Subgrades

Bruce Chappell

Weak Subgrades CBR ≤ 3%

- Design Options
  - Stabilise subgrade
  - Undercut and place subgrade improvement layer (SIL)
  - Drain to improve layer strength (may take time)
  - Use geosynthetics to gain strength
  - Place a bound layer
  - Other options?
- How to mechanistically model option(s)
Mechanistic Modelling Issues

- How well can we compact any modification we do to the subgrade?
  - What is our effective depth of compaction?
- How well can we compact layers above this weak subgrade?
- Will the subgrade strength improve over time?
- What modulus values shall we use in our mechanistic model?

Austroads Pavement Design Guide

- Table 6.4(a) and (b)
  - Give maximum vertical modulus of top sub-layer of base aggregate
  - Table 6.4 (a) for ‘normal’ standard material
  - Table 6.4 (b) for ‘high’ standard material
Table 8.1(d) gives two sub-layering design equations to determine modulus increase above a subgrade.

- One for selected subgrade materials
- One for granular materials
Example 1 – Subgrade CBR 2%

- Subgrade CBR 2%, Ev=20 MPa say
- Lab test 3% lime gives CBR 20%, Ev=200 MPa? I wish.
- Stabilise 300 mm depth, use effective compaction to 250 mm. Model subgrade and stabilised layer.
- Equation (8.1) the top of improvement layer Ev = 20x2^{(250/150)} = 20x3.2=64, Ev=60 MPa? Yikes.
- What Ev do we use?
- Depends on compaction achieved, degree of material binding, sub-layering in model.
- Suggest in this case Ev = 60MPa & sublayered
Example 2 – Subgrade CBR 3%

- Subgrade CBR 3%, $E_v=30$ MPa say
- Try geotextile separation, plus 300 mm unbound granular aggregate and 150 AC, $E=2000$ MPa
- Equation (8.3) modulus at top of the granular layer $E_v = 30 \times 2^{(300/125)} = 30 \times 5.3 = 158$, $E_v=160$ MPa
- Table 6.4(a) ‘normal std’ maximum $E_v=230$ MPa?
- Table 6.4(b) ‘high std’ maximum $E_v=330$ MPa?
- Suggest in this case $E_v = 160$ MPa and sublayered and ignore any improvement from geotextile

Thoughts

- Easy to over-estimate $E_v$ values of layers
- Actual $E_v$ dependent on
  - Ability to compact various layers
  - Degree of binding of materials when stabilising
  - Whether sub-layering is applied (it should be)
- Subgrade stabilisation may not realise the improvement predicted in laboratory tests
- Depth limitations on stabilisation (300 mm) and compaction equipment (250 mm effective)
- What may appear an economical solution may not be if expected parameters are not realised