Pavement Overlay Design

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Why Overlay?

- **Cheaper than reconstruction**
- **Suitable for shorter life span (asset prioritisation)**
- **Faster than reconstruction/stabilisation**

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Types Of Overlay

Several types:

Granular	Ranging from 50 mm to 200 mm or so, pavement material (can be stabilised)
Asphalt	Ranging from 40 mm to 100 mm or so, asphalt (can be several layers). Can be thin or deep lift
Concrete	Mainly over existing rigid pavements (stitched in)

Types Of Overlay

Limits:

Granular overlays up to 10^8 ESA

Asphalt overlays up to 10^7 ESA

Basis for Overlay Design

- Based on pavement deflections (and curvature)
- Need to ensure sufficient existing structural thickness
- Improving road structure to allow it to satisfy increased traffic load (i.e. life)

- Remember drainage is an important consideration

Data Collection

Deflection testing of road

- Benkelman beam
- Falling weight deflectometer (40 kN)
- Deflectometer

Data Collection

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Data Collection

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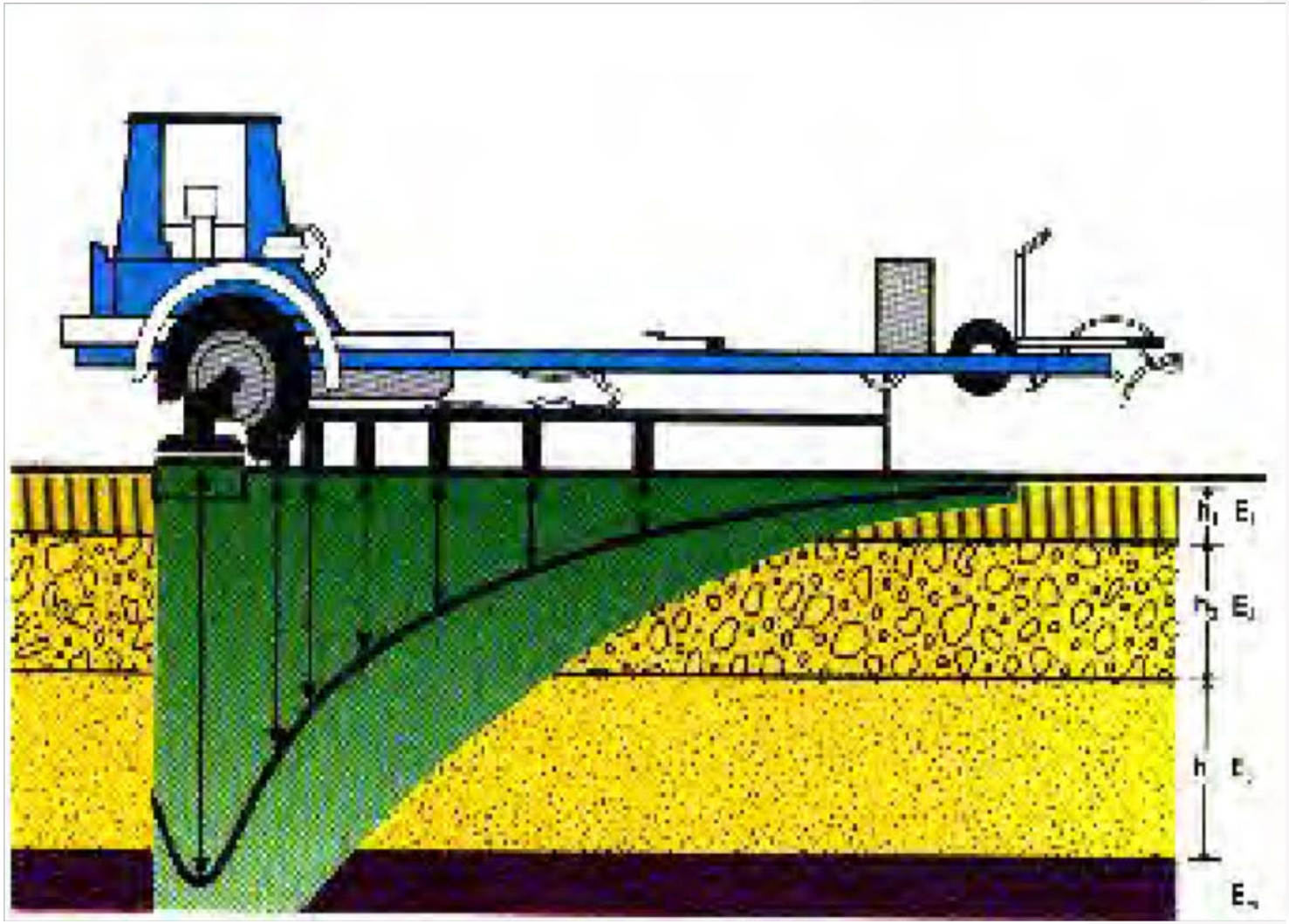
Data Collection



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Data Collection

Curvature = $D_{200} - D_0$

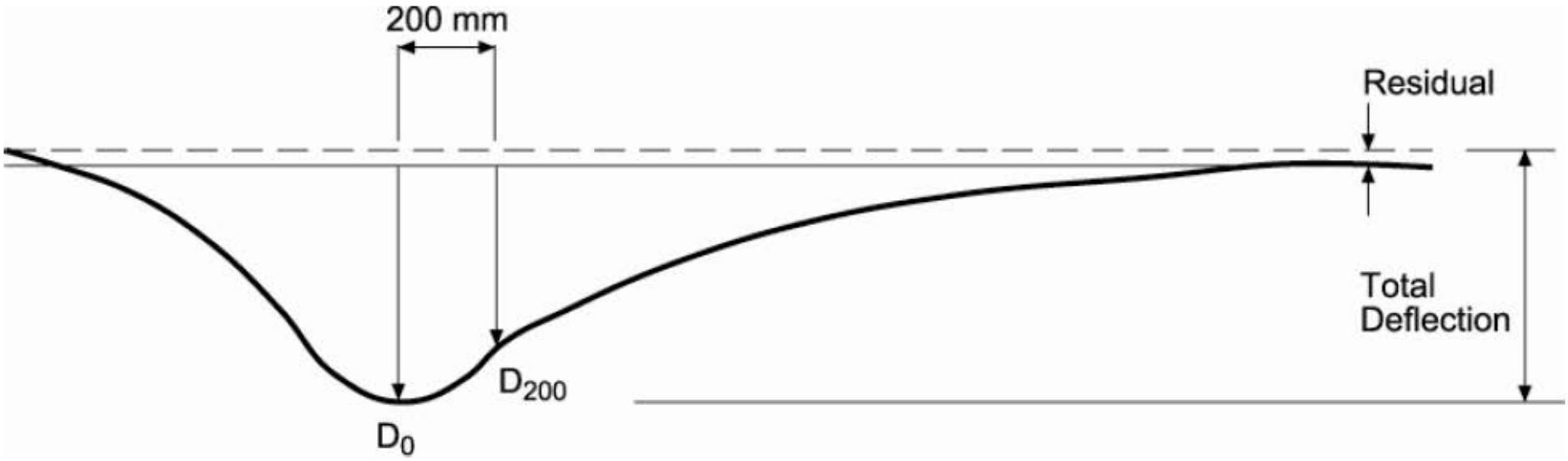

Figure 4.4: Benkelman Beam deflection bowl

- Very important to take pavement temperature

Data Collection

- Pavement Condition
  - Inspect pavement for defects:
    - Rutting (can be indicator of subgrade failure)
    - Shoving (subgrade failure or poor gravel)
    - Cracking (cemented material?)
    - Edge break (thinning on edge?)
  - Austroads Guide to Visual Assessment of Pavement Condition
    - Draw maps
    - Extent of damage
    - Type of damage
    - Drainage conditions!!!
    - In-ground service trenches

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Data Collection

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Data Collection

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Particle size	More than 25% passing 0.425 mm			Less than 25% passing 0.425 mm		
Plasticity index	PI ≤ 10	10 < PI <20	PI ≥ 20	PI ≤ 6 WPI*** ≤ 60	PI ≤ 10	PI > 10
Binder type						
Cement and cementitious blends*						
Lime						
Bitumen						
Bitumen/cement blends						
Granular						
Polymers						
Miscellaneous chemicals**						
Key	Usually suitable		Doubtful or supplementary binder required		Usually not Suitable	

* The use of some chemical binders as a supplementary addition can extend the effectiveness of cementitious binders in finer soils and higher plasticities.

** Should be taken as a broad guideline only. Refer to trade literature for further information.

Overlay Design Procedure

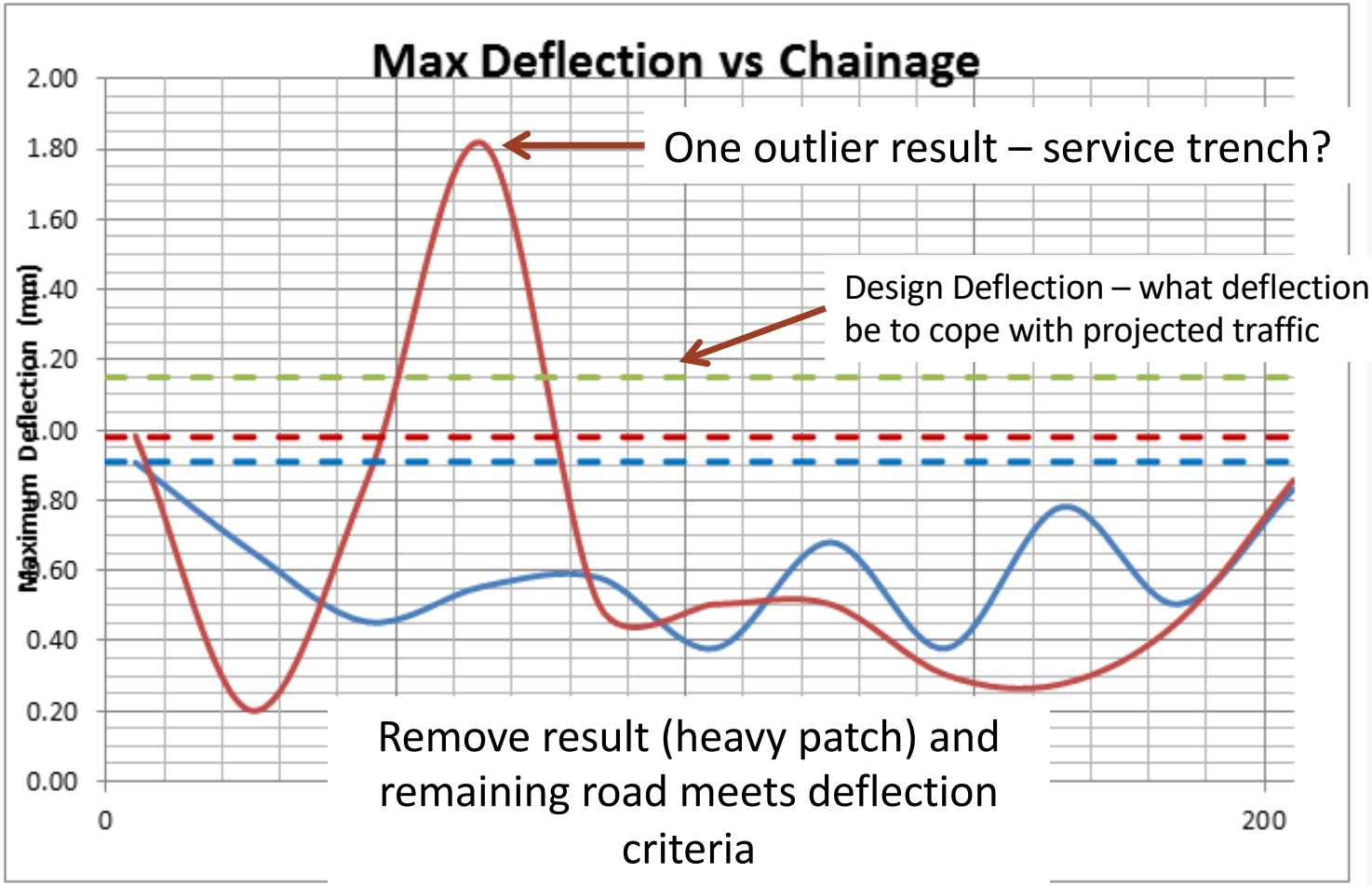
- 

Figure 3: Graphical Results of Benkelman beam testing

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Overlay Design Procedure

- Characteristic Deflection
  - Indicator of overall performance of pavement segment:

$$CD = \mu + fs$$

  - μ = mean of deflection readings
  - f = factor for road function (how busy the road is)

Table 6.3: Recommended values for 'f'

Road Class	f*	Per cent of all deflection measurements which will be represented by the Characteristic Deflection**
Freeway and arterials/highways with lane AADT > 2000	2.00	97.5
Arterials/highways with lane AADT < 2000	1.65	95
Other roads	1.30	90

* f values applicable for 30 or more deflection measurements.

** After identifying areas to be patched/reconstructed.

Where <30 readings, max deflection can be better

Overlay Design Procedure

- Characteristic Curvature
  - Mean of curvature results in segment

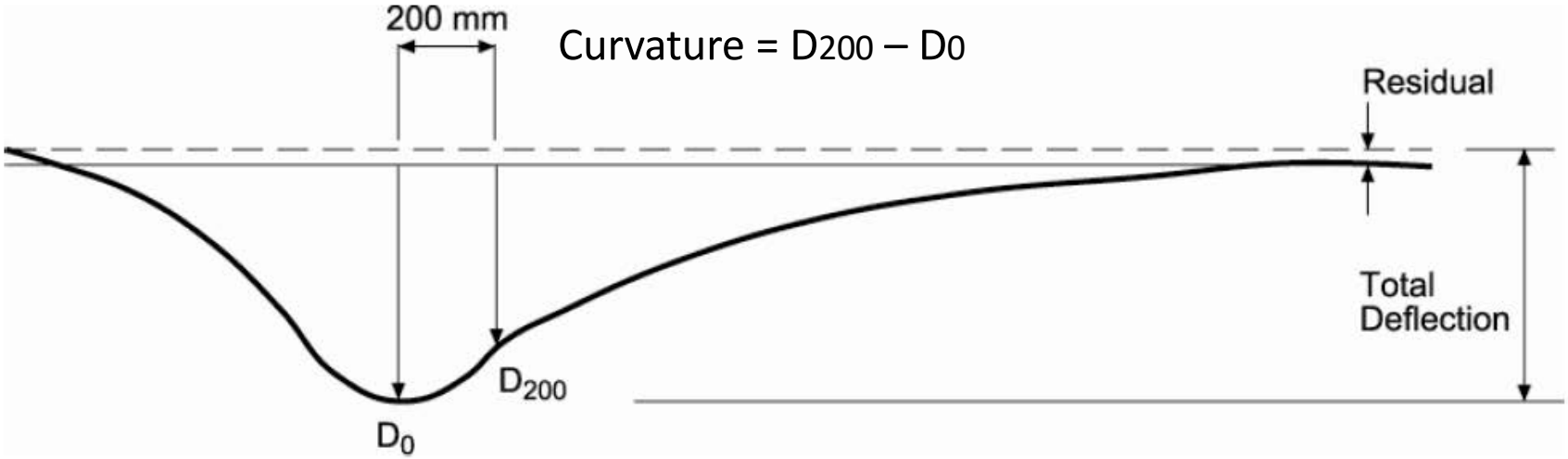

Figure 4.4: Benkelman Beam deflection bowl

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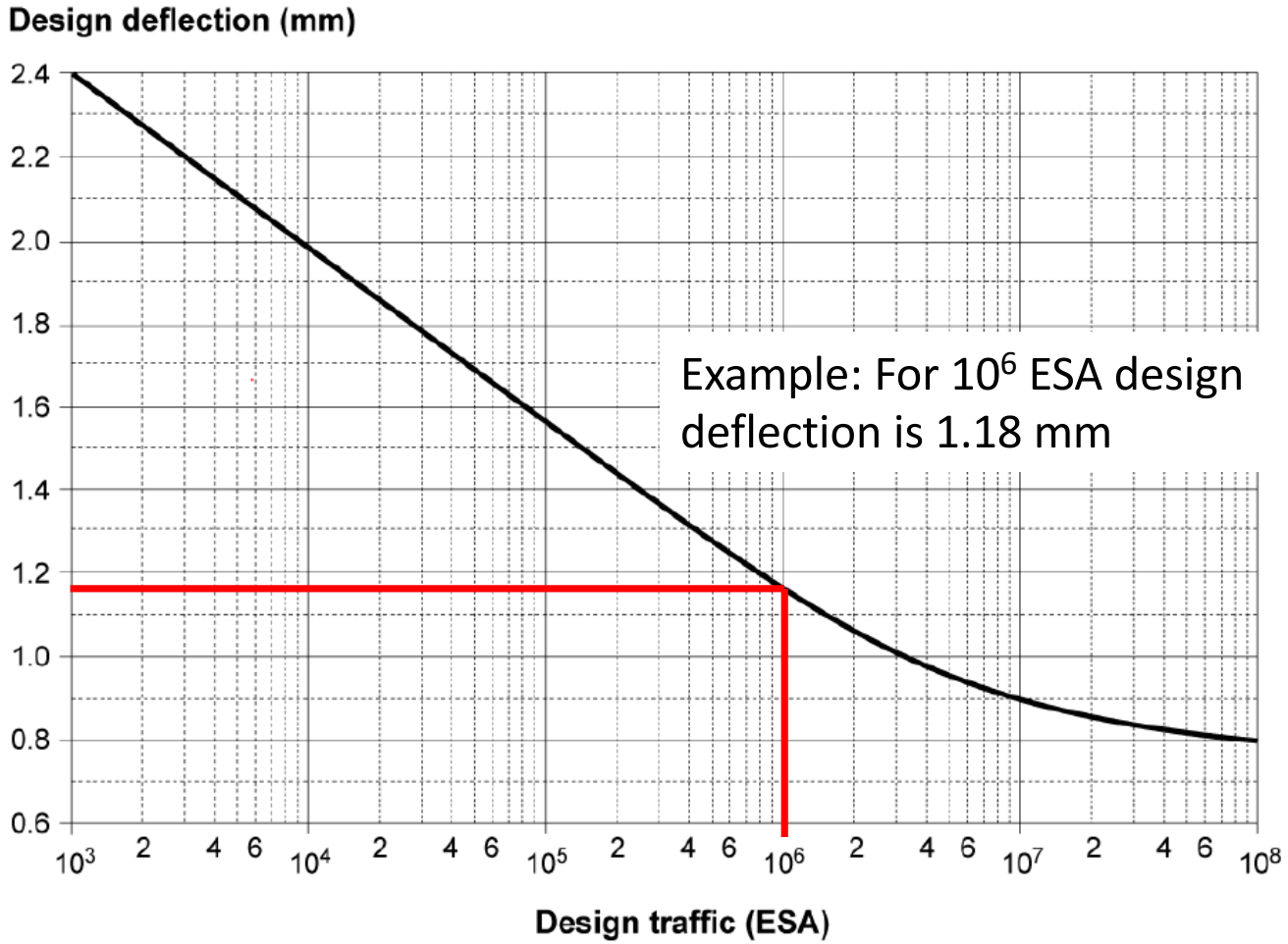
Overlay Design Procedure

- Determine design deflection from design traffic



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Overlay Design Procedure

- Adjust deflection data for
  - Method of collection
  - Seasonal variation
  - Pavement temperature

Deflection Standardisation Factor - Method

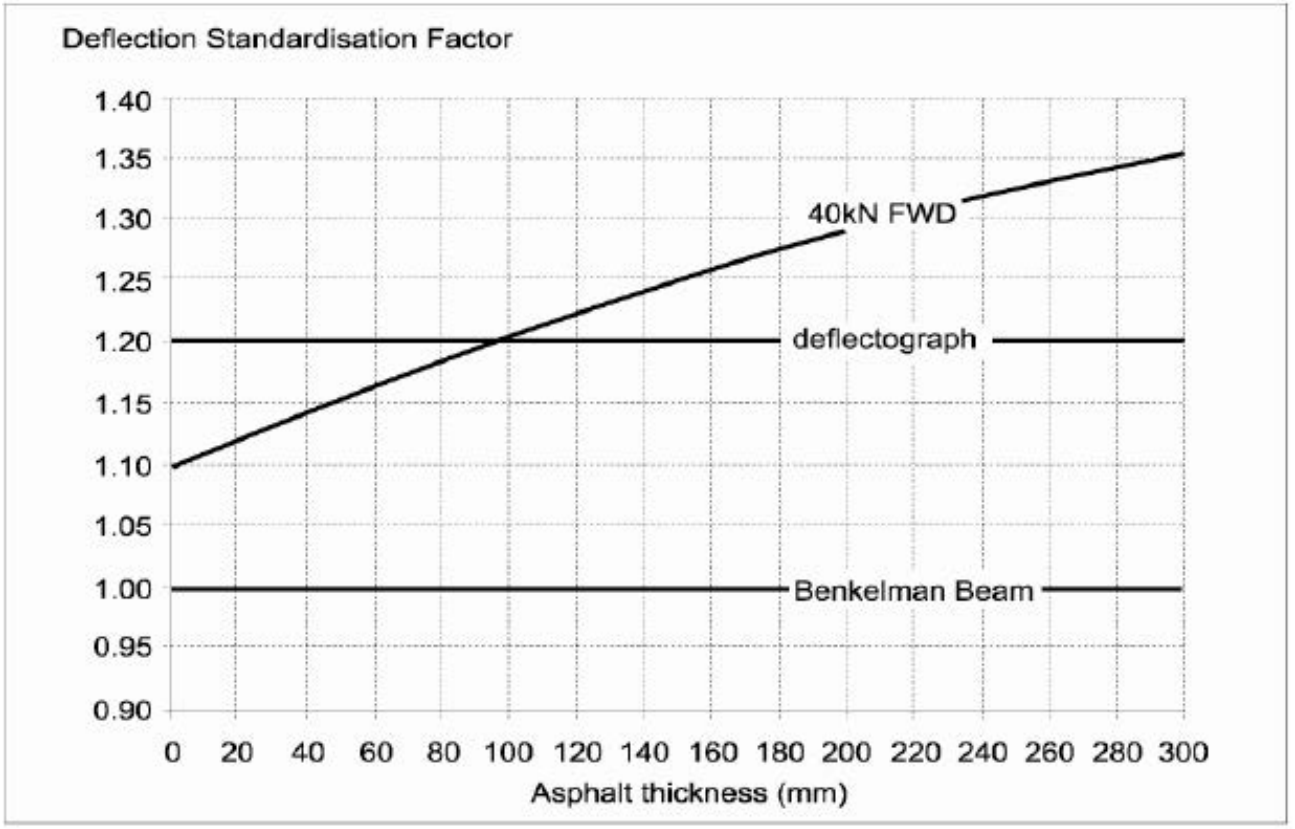

Figure 6.3: Deflection standardisation factors

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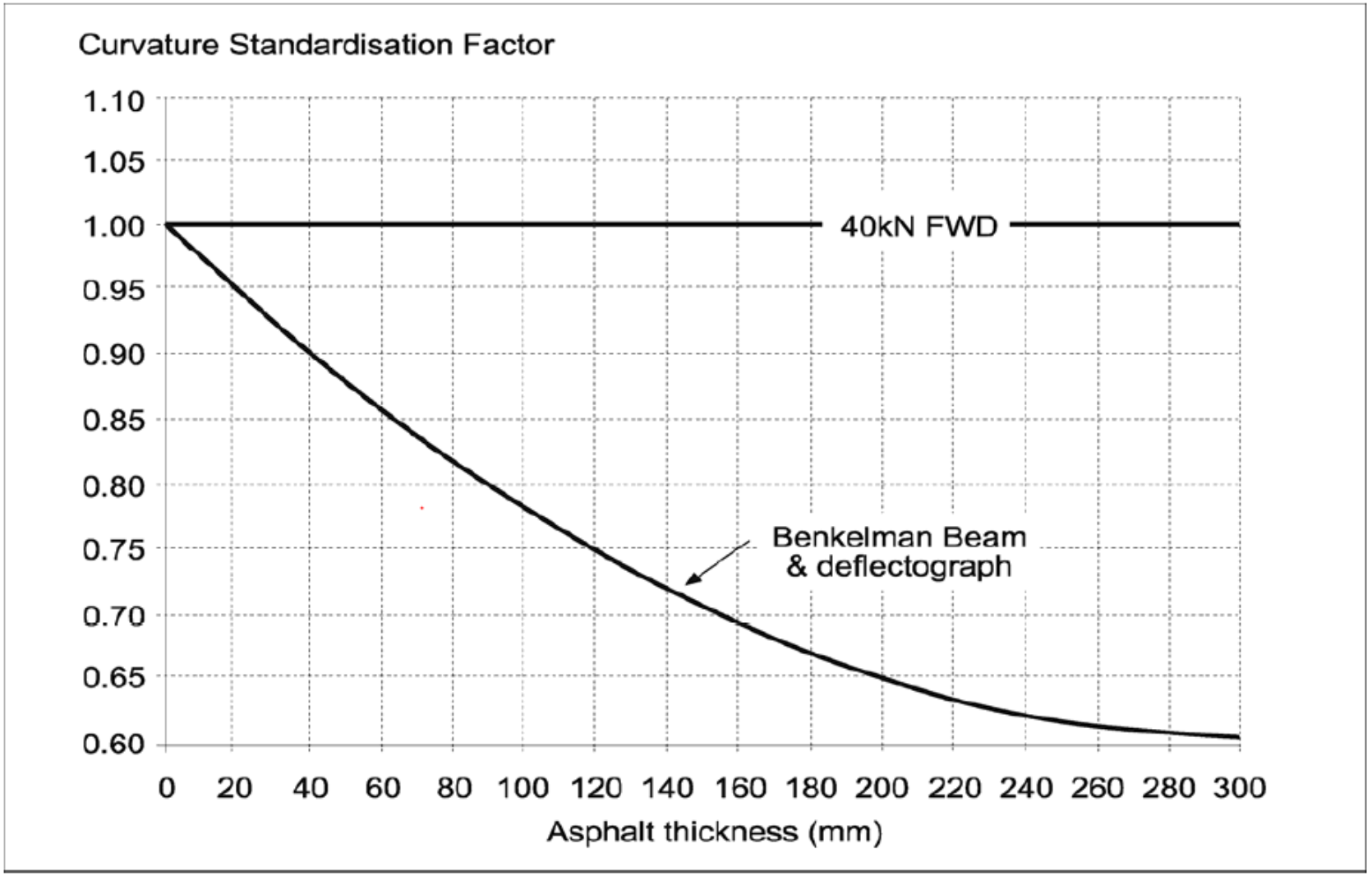
Deflection Standardisation Factor - Method

The design procedures have been developed to utilise deflections generated by the following testing devices:

- 80 kN single axle with dual wheel (tyre pressure 550 kPa) as measured by a Benkelman Beam
- 80 kN single axle with dual wheel (tyre pressure 750 kPa) as measured by a deflectograph
- Falling Weight Deflectometer (FWD) loading with a plate diameter of 300 mm and an applied load of 40 kN (contact stress of 566 kPa).

Deflection Standardisation Factor - Method



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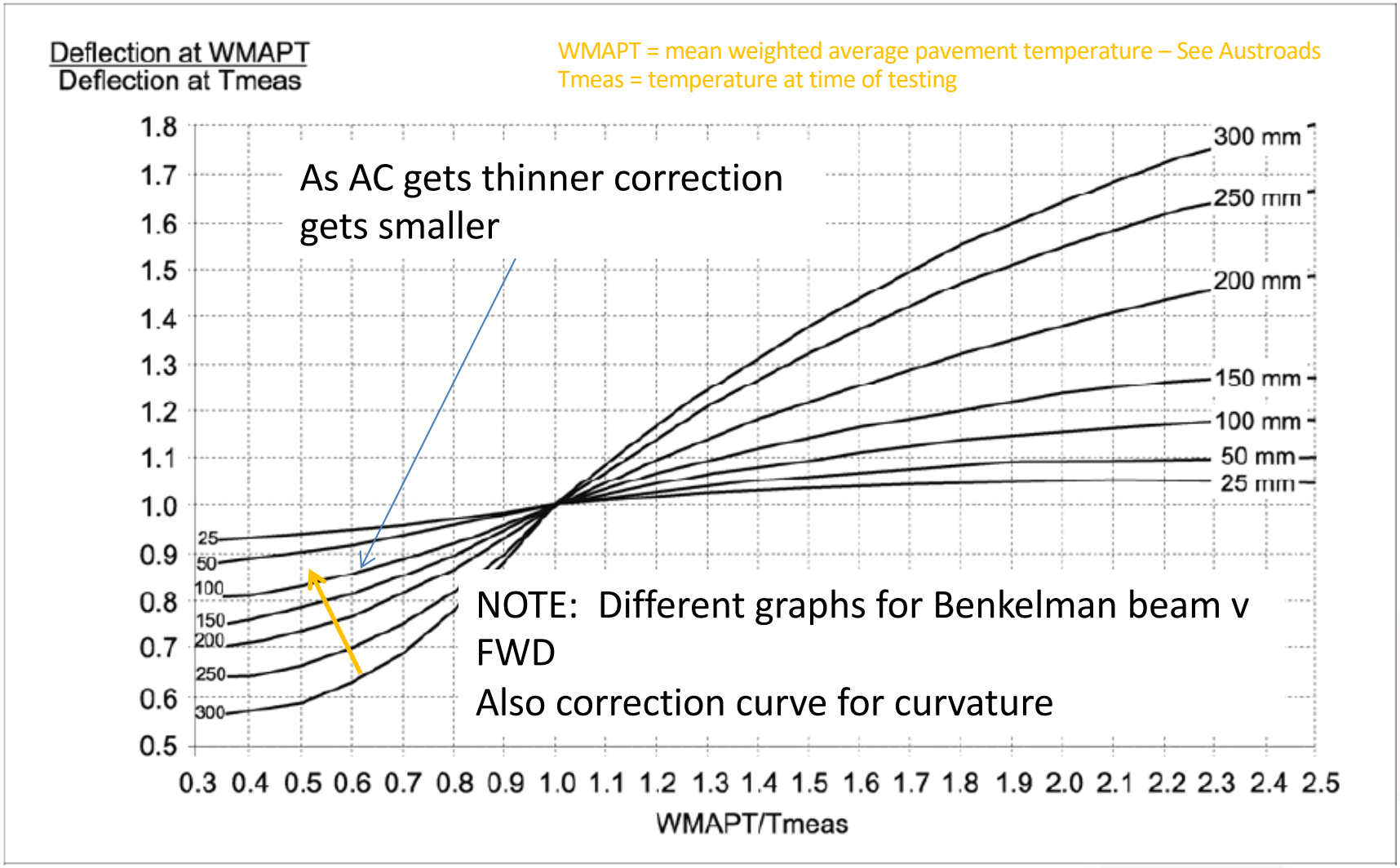
Deflection Standardisation Factor - Temperature



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Deflection Standardisation Factor - Season

- Correction for time / season of testing
- Applied to deflection and curvature
- Note for silt subgrades could be much greater

Table 6.2: Seasonal moisture correction factors

Winter and spring rain (Temperate climates)		Summer rain (Tropical and sub-tropical climates)	
Month when deflections are measured			
January to April[1]	May to December	June to December[1]	January to May
1.3	1.0	1.3	1.0

1. If the water table is less than 3 m below the surface the correction factor is 1.0.

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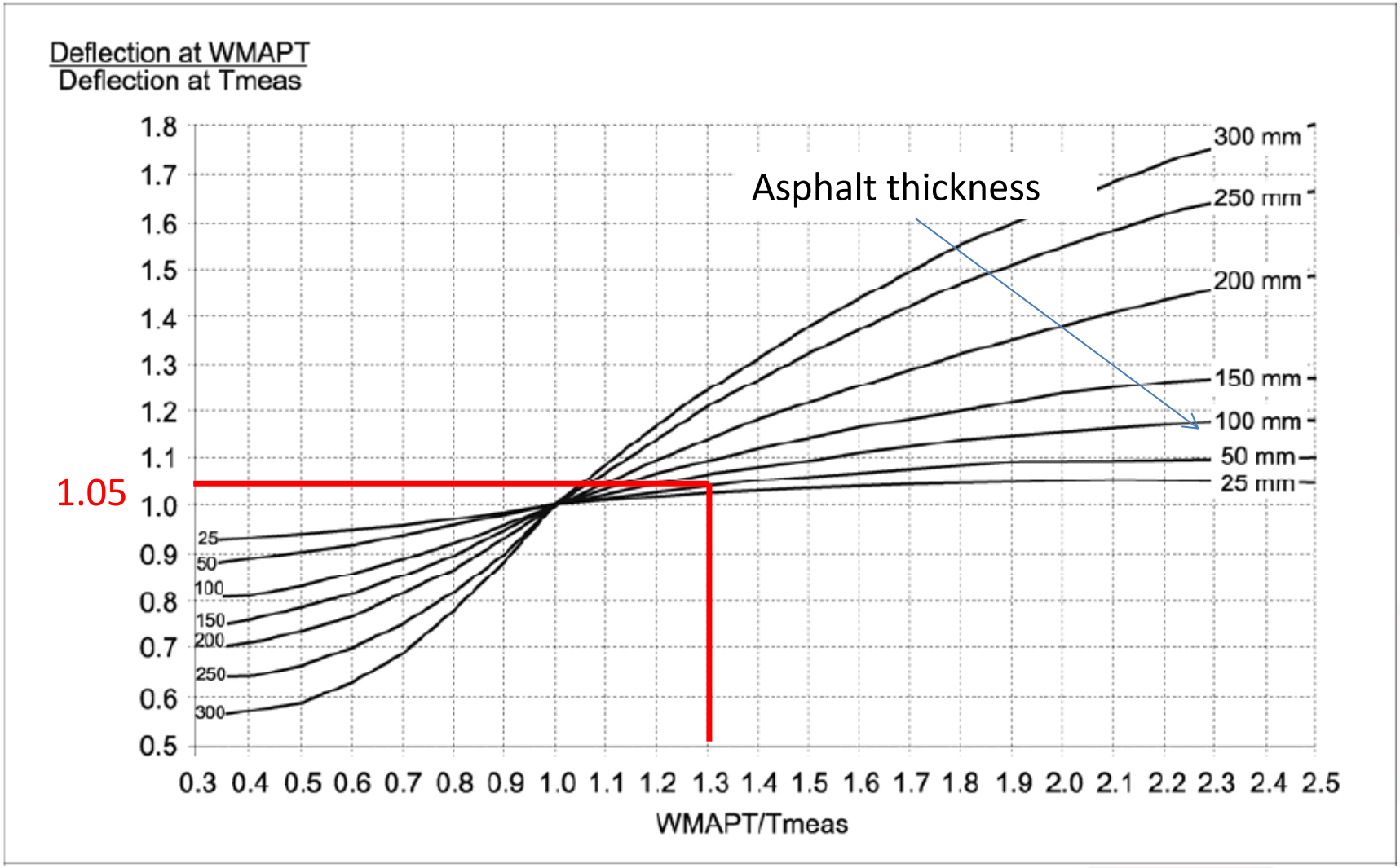
Design Procedure – Example

- We have de
  - Charact
  - Done in
  - AC thick
  - Paveme
  - Going t
  - Adjust fo

NSW and ACT	
Town	WMAPT
Albury	26
Armidale	23
Bathurst	22
Bega	24
Bellingen	30
Blayney	19
Bourke	33
Braidwood	20
Broken Hill	30
Byron Bay	31
Campbelltown	27
Canberra	23
Casino	31
Cessnock	28
Cobar	31
Coffs Harbour	29

Design Procedure – Example



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Design Procedure – Example

- Seasonal factor (temperate climate in Nov) therefore 1.0

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1. If the water table is less than 3 m below the surface the correction factor is 1.0.

Most cases

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Design Procedure – Example

- We have determined parameters
  - Characteristic deflection = 1.2 mm
  - Done in November with Benkelman Beam
  - AC thickness 40 mm
  - Pavement Temperature = 35 degrees
  - Possibly going to mill off 25 mm of AC
  - Kerb and Guttering

  - Corrected CD = 1.58 mm
  - Corrected CC = 0.33 mm
  - For milling depths of up to 50 mm, increase CD and CC by 15% to 25% for each 25 mm of asphalt milled

Design Procedure – Example

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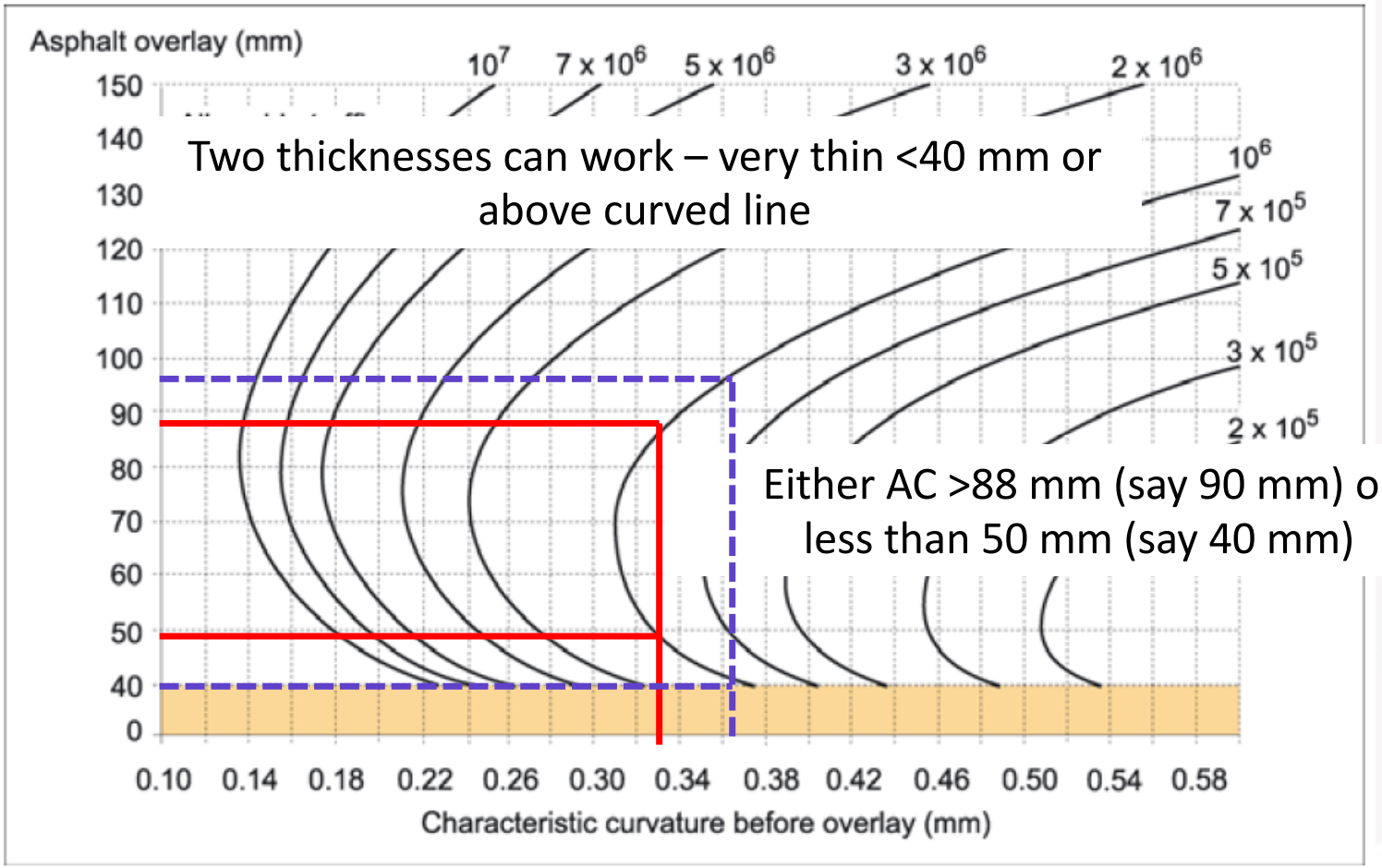
Design Procedure – Asphalt Overlay

- Determine thickness required to avoid asphalt fatigue



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Design Procedure – Asphalt Overlay

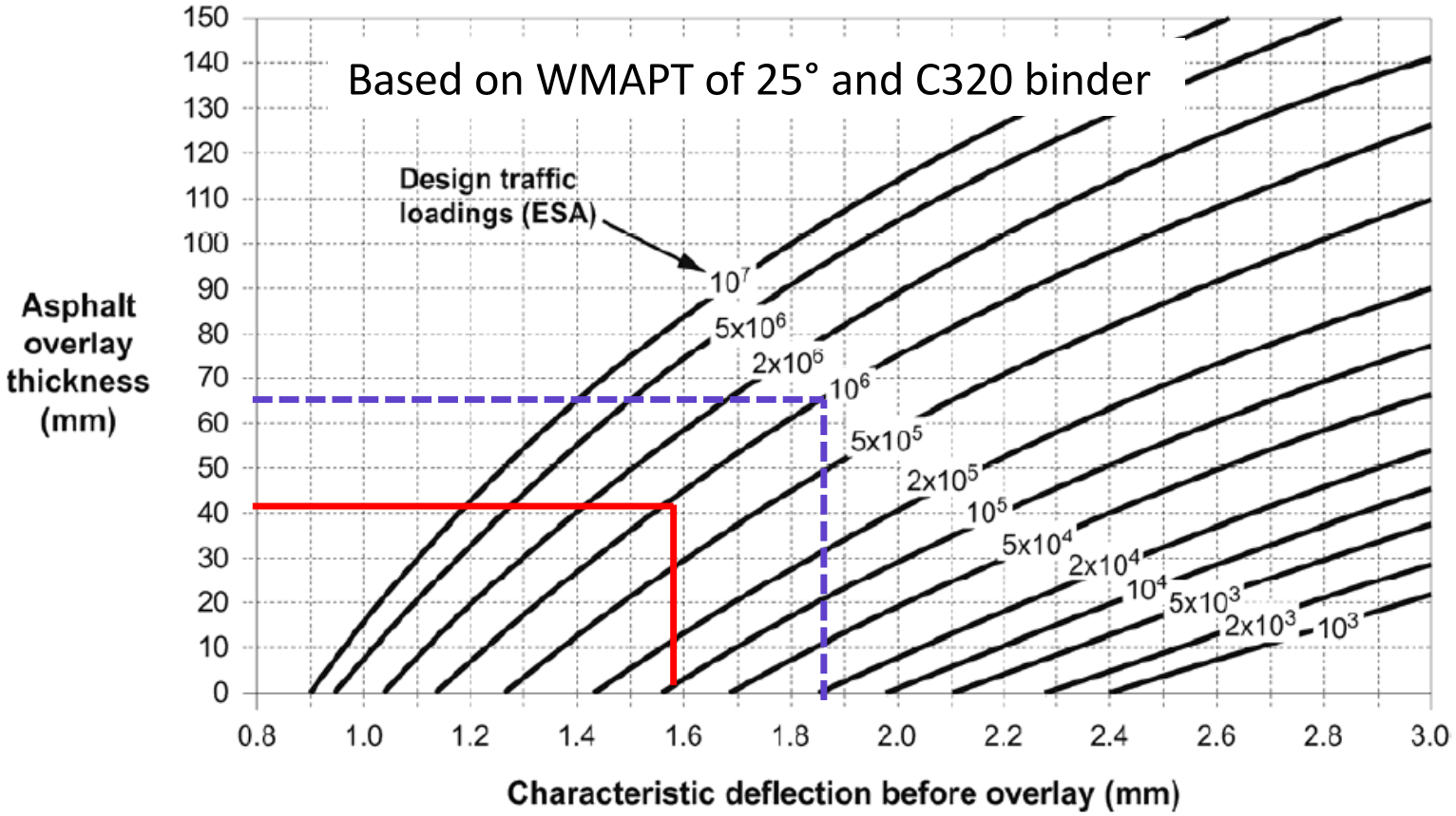
- Can adjust traffic – and hence overlay thickness for non-standard asphalts (provided resultant overlay is less than 50 mm)

Table 6.4: Presumptive allowable traffic loading adjustment factors for wearing course asphalts with non-conventional binders

Pre-1990 description of binder type	Austroads binder grade(1)	Allowable traffic loading adjustment factor
Multigrade	Multigrade 1000/320	1
~ 5% EVA	A30P	1
~5% EMA	A35P	1.5
~3% SBS	A20E	2
PBDA	A25E	2
~5% SBS	A15E	2.5
~6% SBS	A10E	3

Design Procedure – Asphalt Overlay

- Asphalt overlay – thickness required from characteristic deflection



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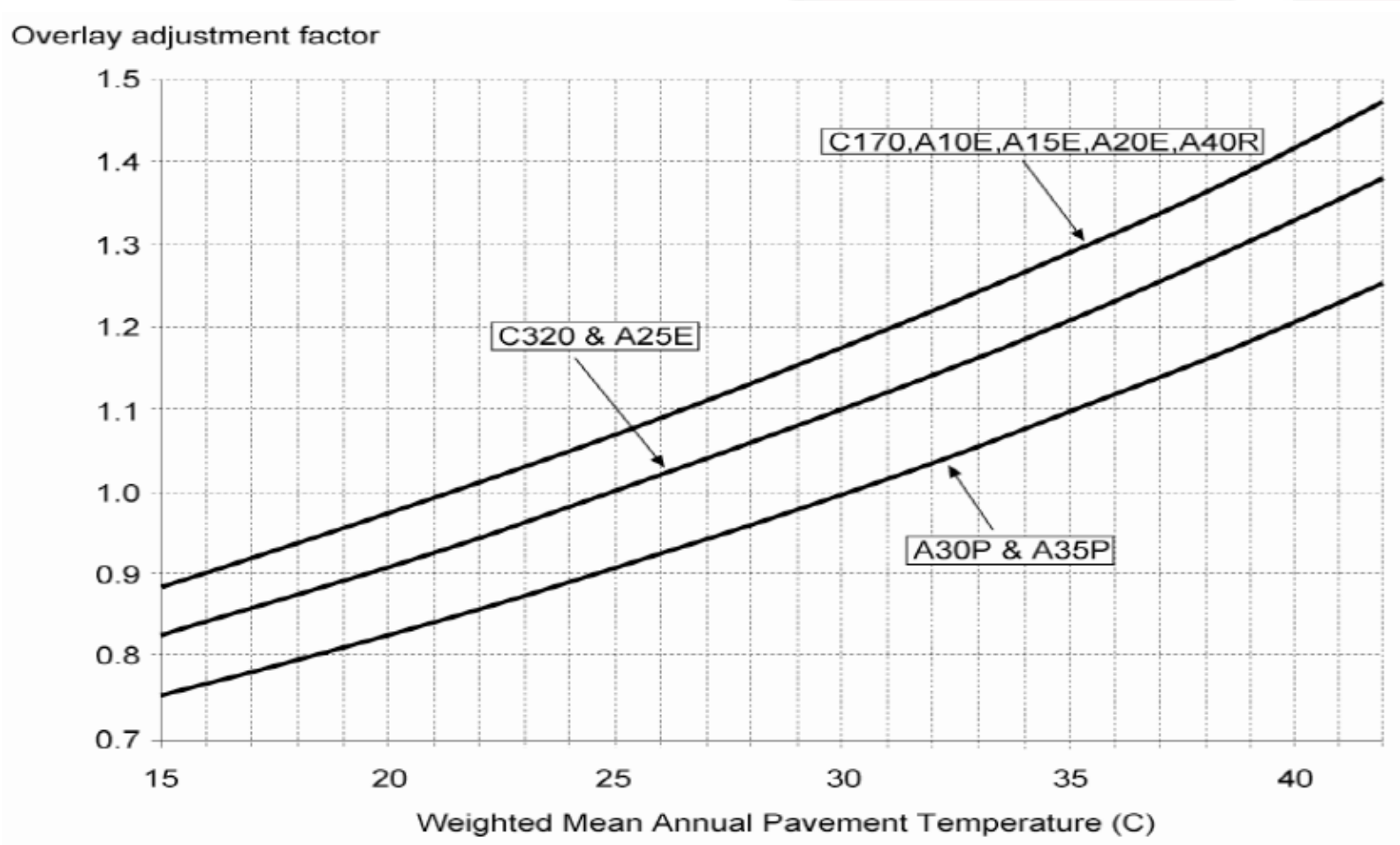
Design Procedure – Asphalt Overlay

- Where WMAPT > 25° or lower stiffness binder used adjust overlay



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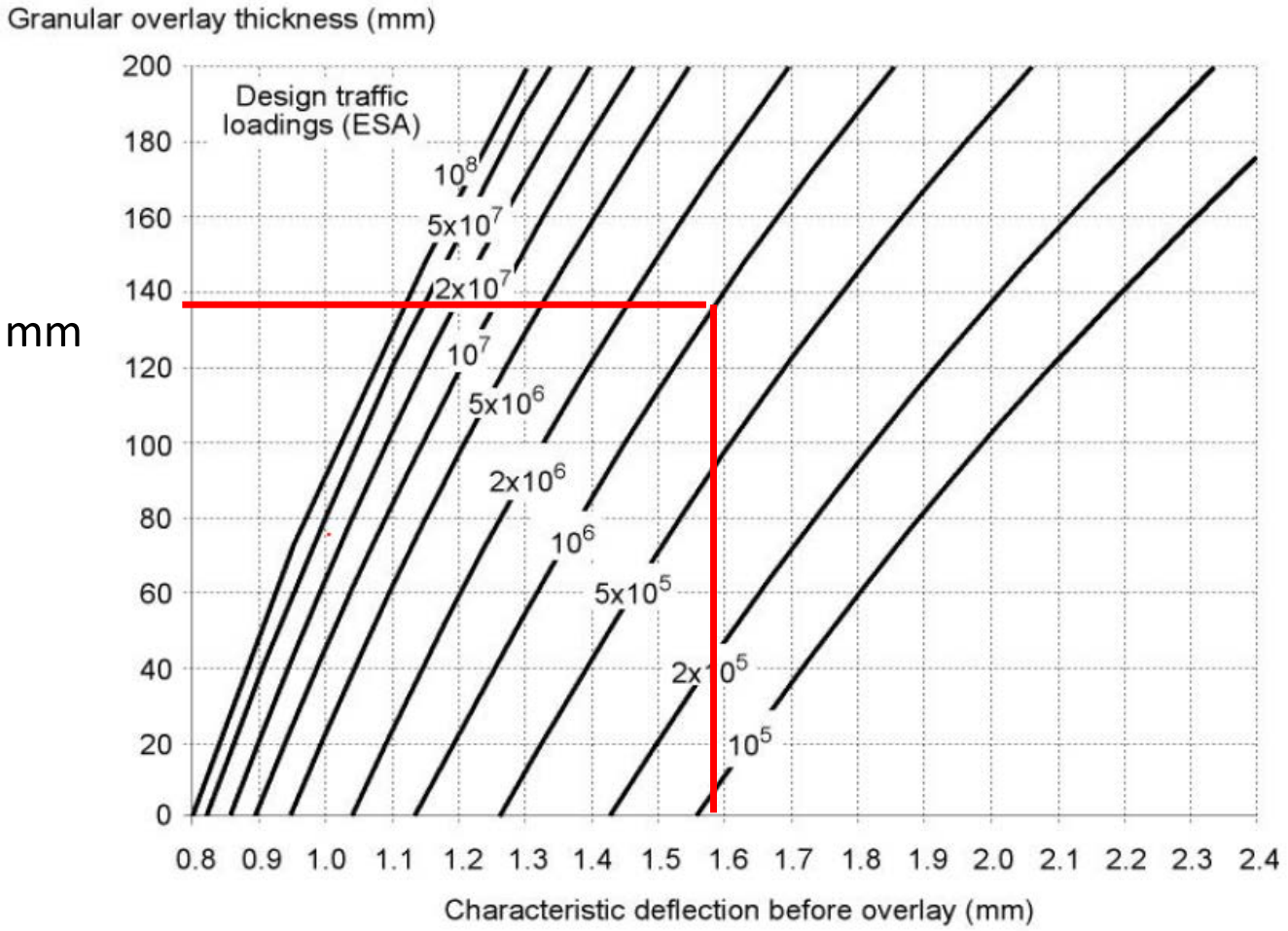
Design Procedure – Granular

- Use following chart for granular overlay thickness required

Need 140 mm



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Overlay Design Example

- For our example:
  - **Asphalt overlay**
    - 40 mm ok for curvature and deflection (or 90 mm AC)
    - If mill 20 mm existing: need 65 mm for deflection (but this would be an issue for asphalt fatigue and would need 95mm AC for curvature)
  - **Granular Overlay**
    - Need 140 mm (but existing kerb and gutter)

Overlay Design Example

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Pavement Overlay Design

THANKS

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