WARRIP

WESTERN AUSTRALIAN ROAD RESEARCH
AND INNOVATION PROGRAM

# Engineering Road Note 9

## Western Australian Supplement to the Austroads Guide to Pavement Technology Part 2: Pavement Structural Design

AN INITIATIVE BY:

THE GOVERNMENT OF WESTERN AUSTRALIA

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# Why?

- Engineering Road Note 9 (ERN9) (2018) is WA's supplement to Austroads Guide to Pavement Technology Part 2: Pavement Structural Design – AGPT02 (2017)
- ERN9 (2018) takes precedence over AGPT02 (2017)
- Address industry comments previously received on ERN9 (2013)
- ERN9 (2018) is intended as a stand-alone guide for empirical design, but otherwise does not repeat information already supplied in AGPT02 (2017)
- Section numbers in ERN9 (2018) align with the section numbers in AGPT02 (2017)
- ERN9 (2018) contains additional clauses over and above AGPT02 (2017), which are identified as e.g. "*3.17 [MRWA] Pavement Joints*"

# What changed in AGPT02 (2017)?

| AGPT02 (2017) | ERN9 (2018) |
|---|---|
| Flexible pavements | |
| • Lime stabilised subgrades | • Content not repeated in ERN9 |
| • Cemented materials | • Added to ERN9 with WA context |
| • Lean-mix concrete | • Added to ERN9 with WA context |
| • Asphalt characterisation | • Added to ERN9 with WA context |
| • Design traffic | • Added to ERN9 with WA context |
|   • Lane capacity limit |   • Not adopted in ERN9 |
| • Axle-strain method - Removal of Standard Axle Repetitions (SARs) | • Added to ERN9 with WA context |

# Changes - Lime stabilised subgrades

| Section | AGPT02 | ERN9 |
|---|---|---|
| Section 5.3.8 | • AGPT02 (2012) - Lime stabilised subgrades not structural<br>• AP-R435-13 (2013) - Proposed procedures for design as selected subgrade NOT subbase<br>• AGPT02 (2017) - Adopted | Refer to AGPT02 |

# Changes - Cemented materials

| Section | AGPT02 | ERN9 |
|---|---|---|
| Section 2.2.3 | Cemented Granular Bases with Sprayed Seal Surfacings | This pavement type not used in WA |
| Section 6.1.1 | Not applicable | Added section for verification of design assumptions |
| Section 6.4.3 | Determination of Design Modulus | Adopted with additions for WA context |
| Section 6.4.6 - 6.4.8 | Fatigue performance - 3 methods | Refer to AGPT02 |

# Changes - Lean-mix concrete

| Section | AGPT02 | ERN9 |
|---|---|---|
| Section 6.6.2 | Discussed as separate material type for subbase concrete | Refer AGPT02 |
| Section 6.6.3 | Discussed as separate material type for subbase concrete for flexible pavements | This pavement type not used in WA |

# Changes - Asphalt characterisation

| Section | AGPT02 | ERN9 |
|---|---|---|
| Section 6.5.3 | Definition of asphalt design modulus - 4 methods | Guidance provided for WA context |
| Section 6.5.4 | Determination of Design Modulus from Direct Measurement of Flexural Modulus | Applies to EME2 only |

# Changes - Asphalt characterisation (continued)

| Section | AGPT02 | ERN9 |
|---|---|---|
| Section 6.5.5 | Determination of Design Modulus from Measurement of ITT Modulus | Guidance provided for WA context |
| Section 6.5.6 | Design Modulus from Bitumen Properties and Mix Volumetric Properties | “*Unless specified otherwise by the Principal, asphalt design modulus shall not be obtained using the Shell nomographs*” |

# Changes - Asphalt characterisation (continued)

| Section | AGPT02 | ERN9 |
|---|---|---|
| Section 6.5.10 | Fatigue criteria - $\frac{SF}{RF}$<br>SF presumptive value = 6 | SF=6 unless for thin asphalt surfacing over granular (clause 1.2(c) 2013), then SF = 23 |
| Section 6.5.11 | Means of Determining Asphalt Fatigue Characteristics - laboratory measurement guidance | "*Unless specified otherwise by the Principal, mix specific fatigue models should not be used*." |

# Asphalt characterisation (Clause 1.2(c) 2013)

- ERN9 (2013) allows the use of a **5-years asphalt fatigue design life** when the asphalt thickness is 60 mm or less and the following conditions are satisfied:
  - the design traffic loading for 40 years is less than or equal to $3x10^7$ ESAs
  - the pavement is well drained
  - the subgrade is Perth sand
  - the sub-base is crushed limestone
  - the basecourse material is either crushed rock base or bitumen stabilised limestone.

# Asphalt characterisation (Clause 6.5.10 2018)

- "Based on empirical observations and analysis of in-service asphalt life of thin asphalt surfacing over granular pavements in Perth, compared to modelled asphalt fatigue life, **a shift factor (SF) of up to 23 may be used when**:
  - the asphalt nominal total thickness is 60 mm or less,
  - the design traffic loading for 40 years is less than or equal to $3x10^7$ ESA,
  - the pavement is well drained,
  - the subgrade is Perth sand,
  - the subbase is crushed limestone and
  - the basecourse material is either high standard crushed rock base, bitumen stabilised limestone or HCTCRB."

# Changes - Design traffic (Lane capacity limit)

| Section | AGPT02 | ERN9 |
| --- | --- | --- |
| Section 7.4.6 | Capacity check<br>Annual number of Heavy Vehicles ≤ lane capacity | “*Unless advised by the Principal no allowance should be made for limiting the design traffic due to saturation. This is to allow for greater future flexibility of the road fleet*” |

# Axle Strain Method (ME Bound Materials) - Removal of SARs

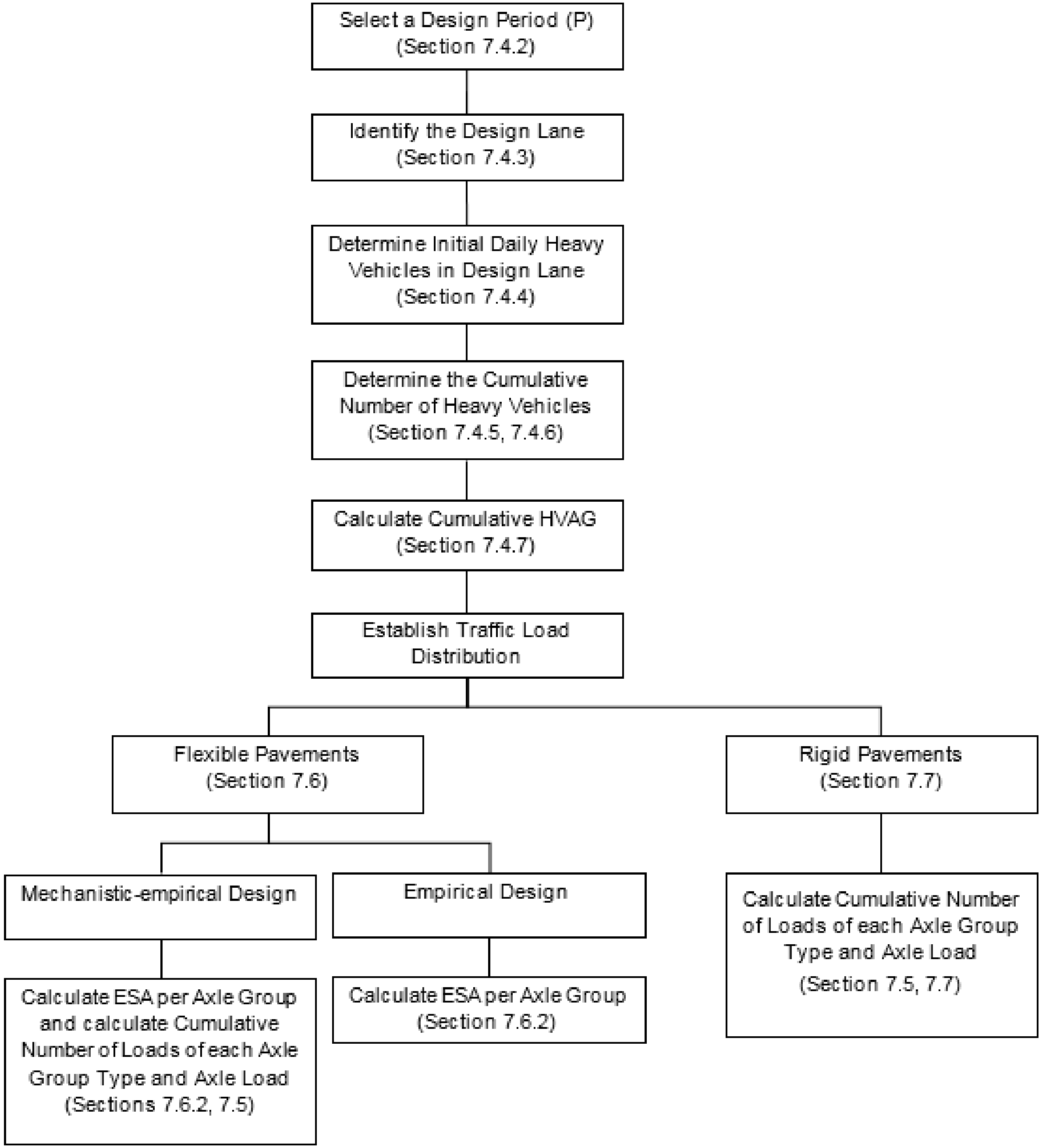
- AGPT02 (2012)

$$SAR = \sum_{i=1}^{m} \left(\frac{L_i}{SL_i}\right)^{LDE}$$

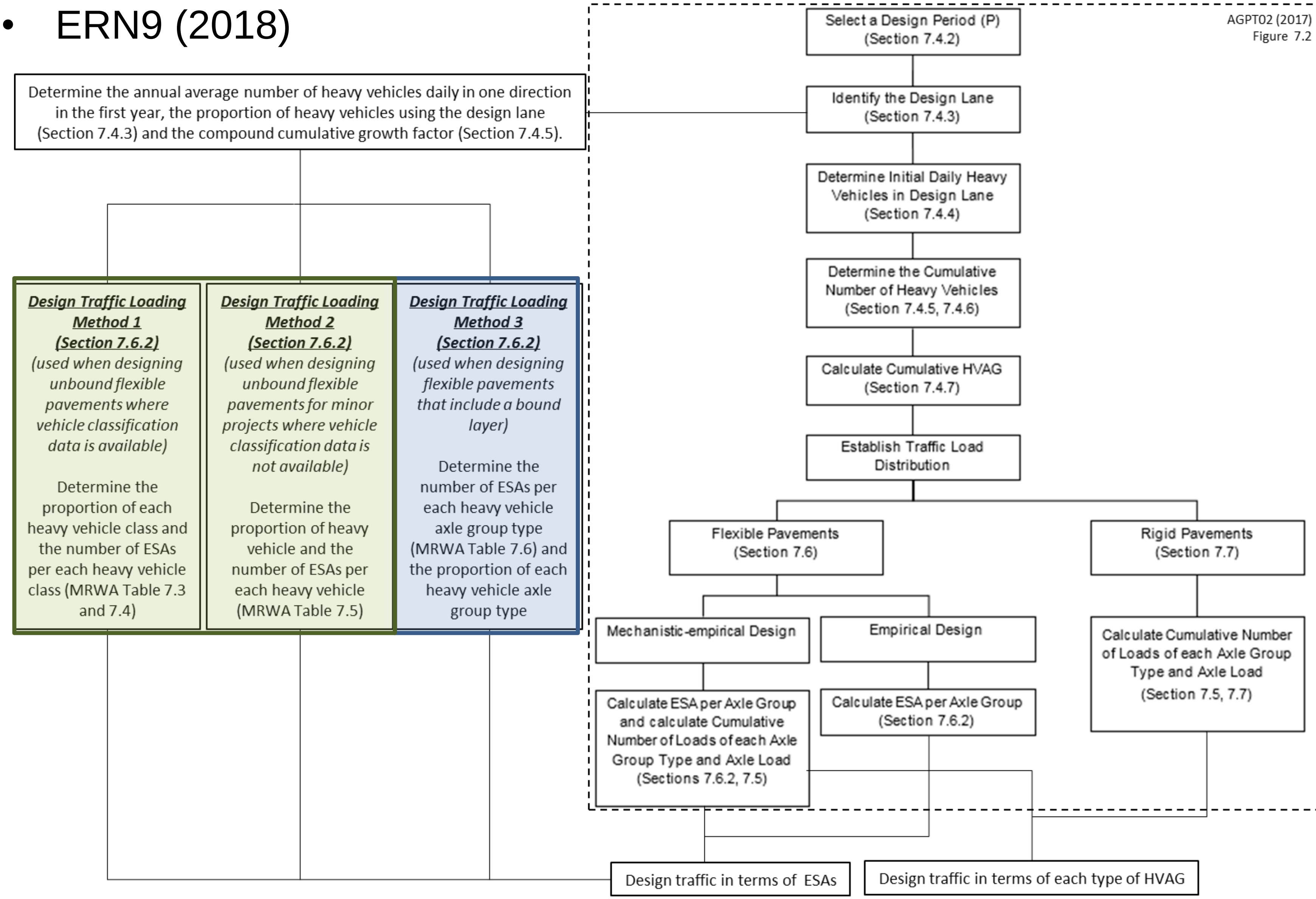
| Axle type | Standard group load [kN] |
|---|---|
| Single Axle - Single Tyres | 53 |
| Single Axle - Dual Tyres | 80 |
| Tandem Axle - Dual Tyres | 135 |
| Triaxle Axle - Dual Tyres | 181 |
| Quad Axle - Dual Tyres | 221 |

| Distress type | LDE |
|---|---|
| Asphalt fatigue | 5 |
| Cemented material/LMC fatigue | 12 |
| Rutting and shape loss | 7 |

- AGPT02 (2017)


Select a Design Period (P)
(Section 7.4.2)
Identify the Design Lane
(Section 7.4.3)
Determine Initial Daily Heavy Vehicles in Design Lane
(Section 7.4.4)
Determine the Cumulative Number of Heavy Vehicles
(Section 7.4.5, 7.4.6)
Calculate Cumulative HVAG
(Section 7.4.7)
Establish Traffic Load Distribution
Flexible Pavements
(Section 7.6)
Rigid Pavements
(Section 7.7)
Mechanistic-empirical Design
Empirical Design
Calculate Cumulative Number of Loads of each Axle Group Type and Axle Load
(Section 7.5, 7.7)
Calculate ESA per Axle Group and calculate Cumulative Number of Loads of each Axle Group Type and Axle Load
(Sections 7.6.2, 7.5)
Calculate ESA per Axle Group
(Section 7.6.2)

- ERN9 (2018)


Determine the annual average number of heavy vehicles daily in one direction in the first year, the proportion of heavy vehicles using the design lane (Section 7.4.3) and the compound cumulative growth factor (Section 7.4.5).
Design Traffic Loading Method 1 (Section 7.6.2)
(used when designing unbound flexible pavements where vehicle classification data is available)
Determine the proportion of each heavy vehicle class and the number of ESAs per each heavy vehicle class (MRWA Table 7.3 and 7.4)
Design Traffic Loading Method 2 (Section 7.6.2)
(used when designing unbound flexible pavements for minor projects where vehicle classification data is not available)
Determine the proportion of heavy vehicle and the number of ESAs per each heavy vehicle (MRWA Table 7.5)
Design Traffic Loading Method 3 (Section 7.6.2)
(used when designing flexible pavements that include a bound layer)
Determine the number of ESAs per each heavy vehicle axle group type (MRWA Table 7.6) and the proportion of each heavy vehicle axle group type
AGPT02 (2017) Figure 7.2
Select a Design Period (P) (Section 7.4.2)
Identify the Design Lane (Section 7.4.3)
Determine Initial Daily Heavy Vehicles in Design Lane (Section 7.4.4)
Determine the Cumulative Number of Heavy Vehicles (Section 7.4.5, 7.4.6)
Calculate Cumulative HVAG (Section 7.4.7)
Establish Traffic Load Distribution
Flexible Pavements (Section 7.6)
Rigid Pavements (Section 7.7)
Mechanistic-empirical Design
Empirical Design
Calculate Cumulative Number of Loads of each Axle Group Type and Axle Load (Section 7.5, 7.7)
Calculate ESA per Axle Group and calculate Cumulative Number of Loads of each Axle Group Type and Axle Load (Sections 7.6.2, 7.5)
Calculate ESA per Axle Group (Section 7.6.2)
Design traffic in terms of ESAs
Design traffic in terms of each type of HVAG

# Design traffic loading – Calculation methods

- Typical sealed granular pavement
  - Use Method 1 (same as Method 1 (ERN9 2013))
  - Does not require complex TLD, only heavy vehicles by class
  - Use Method 2 only if vehicle class data is not practical
- Pavement including a bound layer or asphalt surfacing
  - Use AGPT02 Fig 7.2 where TLD available
  - ERN9 (2018) includes an interim Method 3 for use where a TLD is not yet available

# Design traffic loading - Method 1

- Traffic data in terms of heavy vehicles by class available
- As a minimum this method should be used to estimate design traffic
- Only valid when there is no bound layer
- Typical input:
    - AADT in one direction = 238
    - Annual heavy traffic growth rate = 3%
    - Rural main and secondary road
    - 2 lanes in each direction
    - Percentage of heavy vehicles by class =

| C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 |
|---|---|---|---|---|---|---|---|---|---|
| 8.1 | 6.7 | 1.4 | 0.9 | 0.5 | 1.0 | 0.5 | 3.8 | 2.4 | 13.1 |

# Design traffic loading - Method 2

- Only for minor projects where no data available
  - This method is not preferred as representative class data should be sourced
- Traffic data in terms of proportion of heavy vehicles
- Only valid when there is no bound layer
- Typical input:
    - AADT in one direction = 238
    - Percentage heavy vehicles of total traffic = 10%
    - Rural main and secondary road
    - 2 lanes in each direction

# Design traffic loading - Method 3

- Traffic data in terms of proportion of each heavy vehicle axle group type
- Must be used for projects that includes a bound layer (asphalt or cemented)
- Example input:
    - AADT in one direction = 238
    - Annual heavy traffic growth rate = 3%
    - Rural main and secondary road
    - 2 lanes in each direction
    - TLD Roe Highway (H018) SLK13.03, Jandakot (MRWA Table A 13)

# Where to from here?

- Two or three volunteers for independent review
- Main Roads working towards producing TLDs later this year
- WARRIP workshop to launch ERN9 (2018) with industry – half day?

# QUESTIONS?