ENGINEERING REPORT

Rigid Pavement Design Report

Based on Austroads Guide to Pavement Technology Part 2: Pavement Structural Design (AGPT02-26)



Sample Project

PREPARED & SUBMITTED BY

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TABLE OF CONTENTS

Executive Summary 1

1. Introduction 2

1.1 General 2

1.2 Design Philosophy 2

2. Design Traffic 4

2.1 Heavy Vehicle Traffic 4

2.2 Traffic Parameters 4

2.3 Design Traffic 5

2.4 Axle Loads and Their Effect on the Concrete Pavement 5

3. Pavement Design Parameters 7

3.1 Design Period 7

3.2 Subgrade and Subbase 7

3.3 Concrete 7

3.4 Project Reliability and Load Safety Factor 7

3.5 Shoulders 7

4. Computation of Base Thickness 8

4.1 Fatigue and Erosion Analysis 8

4.2 Comparison of Base Types 8

4.3 Recommended Pavement 8

Annexure – A (Key Plan and Location Map) 10

Annexure – B (Design Calculations by Austroads AGPT02-26) 11

Annexure – C (Typical Cross Sections) 19

Annexure – D (Soil Investigation Results of CBR) 21

Sample report: illustrative data, not for design use

EXECUTIVE SUMMARY

The proposed Sample Project (Road 1) will form an important regional transport link within and around the project area. The road traverses predominantly rural and sparsely developed areas, providing connectivity between local communities and supporting the movement of people, goods and commercial traffic. The project corridor forms part of the wider regional road network that connects inland areas with the national highway system and with important trade and economic centres.

The pavement has been designed in accordance with Austroads Guide to Pavement Technology Part 2: Pavement Structural Design (AGPT02-26). The design of the pavement structure includes selecting materials of adequate strength and placing them at the proper thickness, so that the pavement carries the anticipated traffic loading over its design period without structural distress.

Design basis. The concrete pavement has been designed with Chapter 9 of the Austroads Guide, a mechanistic-empirical method based on the Portland Cement Association (PCA) procedure revised for Australian conditions. The design traffic is the number of heavy vehicle axle groups (HVAG) with their full load spectrum; each axle load is multiplied by the load safety factor of the project reliability, and the base thickness is the least thickness for which both concrete fatigue and sub-base erosion stay within 100% over the design period, on the effective subgrade strength given by the sub-base and with the minimum base and sub-base thicknesses. Several base types are designed for the same traffic and compared on construction and whole-of-life cost.

For the design traffic of 1.29×10^7 heavy vehicle axle groups and a subgrade design CBR of 20% on 150 mm lean-mix concrete (LCS), the Austroads Guide allows several concrete base types. The following have been designed for the same traffic, subgrade, sub-base and reliability:

- **PCP undowelled**: 265 mm base; passes.
- **PCP dowelled**: 190 mm base; passes, ranked first.
- **JRCP**: 190 mm base; passes, ranked first.
- **CRCP**: 190 mm base; passes, ranked first.
- **SFCP**: 265 mm base; qualified.

The preferred option is set out below; part 4 of this report compares the options in detail.

Based on the design traffic and subgrade parameters set out in this report, the following concrete pavement is recommended:

Pavement layer	Thickness (mm)
Plain concrete (PCP), undowelled joints	265
150 mm lean-mix concrete (LCS)	150

Design traffic 1.29×10^7 heavy vehicle axle groups (HVAG); subgrade design CBR 20% (effective CBR 75.0% on the subbase); concrete flexural strength 4.5 MPa; project reliability 95% (load safety factor 1.30). Total fatigue 0.0% and erosion 94.9% at the design thickness: **PASSES**.

The key plan and location map are included as Annexure A, the design calculations by Austroads AGPT02-26 in Annexure B, typical cross sections in Annexure C and the soil investigation results of CBR in Annexure D of this report.

1. INTRODUCTION

1.1 General

The proposed Sample Project (Road 1) will form an important regional transport link within and around the project area. The road traverses predominantly rural and sparsely developed areas, providing connectivity between local communities and supporting the movement of people, goods and commercial traffic. The project corridor forms part of the wider regional road network that connects inland areas with the national highway system and with important trade and economic centres.

The development of the Sample Project is expected to improve regional accessibility, reduce travel times and vehicle operating costs, and enhance the movement of goods and passengers, contributing to the socio-economic development of the surrounding areas. The project also forms part of the wider improvement of road infrastructure, supporting connectivity with major routes and access to markets, services and other economic centres.

The proposed road generally follows the existing transport corridor, with improvements and realignments introduced where required to meet the applicable highway standards, improve road geometry, enhance safety and provide an appropriate level of service for the anticipated traffic. The road is expected to carry a significant share of heavy commercial vehicles, many of them loaded close to or above the legal axle load limits, so the axle loads of the heavy vehicles govern the pavement design.

The pavement design has been developed in accordance with the Austroads Guide to Pavement Technology Part 2: Pavement Structural Design (AGPT02-26), considering the projected traffic and its axle loads, the strength and moisture condition of the subgrade, the locally available construction materials, the climate and drainage of the project area, and the construction and maintenance capability expected for the project. The objective is a pavement that carries the design traffic over its design period with an acceptable level of serviceability, at the lowest whole-of-life cost.

The key plan and location map of the project road are provided as Annexure A.

1.2 Design Philosophy

The concrete pavement has been designed in accordance with Chapter 9 of the Austroads Guide to Pavement Technology Part 2 (AGPT02-26). The Austroads base thickness design method is based on the USA Portland Cement Association (PCA) method (Packard 1984), with revisions to suit Australian conditions, and assumes that the base and subbase are not bonded.

The base thickness is the least thickness for which two distress modes stay within their limits over the design period:

• **flexural fatigue** of the concrete base, from the repeated tensile stresses at the bottom of the slab; and

• **erosion** of the subbase or subgrade at joints and slab edges, from the repeated deflections that pump fine material from under the slab.

Rigid pavements are relatively insensitive to the number of load repetitions but very sensitive to the magnitude of the axle loads (Section 9.3.4). The design traffic is therefore expressed as heavy vehicle axle groups (HVAG) with their full load spectrum, not as equivalent standard axles. Each axle load is multiplied by a load safety factor that reflects the project reliability. For every axle group type and load the allowable repetitions in fatigue and in erosion are calculated, and the damage (expected / allowable repetitions) is summed over the spectrum; both totals must not exceed 100% (Section 9.4).

The support under the slab is described by the effective subgrade CBR, which rises with a bound or lean-mix concrete subbase (Figure 9.1). A minimum subbase (Table 9.1) and a minimum base thickness (Table 9.7) apply. A concrete shoulder (or a structural kerb) reduces the edge stresses and erosion. For lightly trafficked roads below 10^6 HVAG only fatigue governs (Section 12.9).

All rigid pavements are designed on the presumption of uniform support. The joints, dowels, tie bars and reinforcement are detailed after the thickness design, and several base types are designed for the same traffic and compared on cost and whole-of-life cost.

2. DESIGN TRAFFIC

The traffic loading is expressed as the cumulative number of heavy vehicle axle groups (HVAG) in the design lane over the design period, with their axle loads, derived in accordance with Chapter 7 of the guide.

2.1 Heavy Vehicle Traffic

#	Vehicle	Per day (two-way)	Axle groups: load → ESA	ESA / vehicle (information)
1	Class 9 - Six axle articulated AASHTO Truck Type 1 (Composite): 150/day in 2026, grown to 2029	164	SAST 5.4 t (53.4 kN) → 1.029 TADT 19.1 t (186.8 kN) → 3.668 TRDT 33.6 t (329.2 kN) → 10.700	15.397
2	Class 8 - Five axle articulated AASHTO Truck Type 2: 125/day in 2026, grown to 2029	137	SAST 5.9 t (57.8 kN) → 1.417 TADT 21.8 t (213.5 kN) → 6.257 TADT 21.8 t (213.5 kN) → 6.257	13.932
3	Class 8 - Five axle articulated AASHTO Truck Type 3: 125/day in 2026, grown to 2029	137	SAST 5.9 t (57.8 kN) → 1.417 TADT 11.8 t (115.7 kN) → 0.539 TADT 11.8 t (115.7 kN) → 0.539	2.494

ESA of an axle group = (load / standard load)^4 (Equation 37), shown for comparison with flexible designs; the concrete design uses the axle groups and their loads.

2.2 Traffic Parameters

Parameter	Value
Design period P	20 years
Annual heavy vehicle growth R	3%
Direction factor DF	1
Lane distribution factor LDF	1
Cumulative growth factor CGF (Equation 31)	26.87

Direction factor

A direction factor of 1.0 has been adopted: the heavy vehicle numbers used are those of the design direction only.

Lane distribution factor

All heavy vehicles travelling in the design direction use the design lane (lane distribution factor 1.0), as on a road with one lane in each direction.

2.3 Design Traffic

Quantity	Value
Heavy vehicles per day in the design lane, first year (Equation 30)	438.0
Cumulative heavy vehicles in the design lane N_{DT} (Equation 32)	4.30×10^6
Axle groups per heavy vehicle N_{HVAG}	3.00
Design traffic $N_{DT,HVAG}$	**1.29×10^7 HVAG**
ESA per axle group (information)	3.634
ESA per heavy vehicle, average damage factor (information)	10.903
Design traffic DESA (information)	4.68×10^7 ESA

2.4 Axle Loads and Their Effect on the Concrete Pavement

The axle group loads of the heavy vehicles are compared below with the legal axle load limits of the National Highway Authority (NHA, NHSO 2000 regime: front single axle 5.5 t, single axle 12 t, tandem 22 t, tridem 31 t).

Vehicle	Axle group	Load (t)	Legal limit (t)	Load / limit	Status
Class 9 - Six axle articulated (AASHTO Truck Type 1 (Composite): 150/day in 2026, grown to 2029)	SAST — single axle, single tyres	5.4	5.5	99%	within
Class 9 - Six axle articulated (AASHTO Truck Type 1 (Composite): 150/day in 2026, grown to 2029)	TADT — tandem axle, dual tyres	19.1	22.0	87%	within
Class 9 - Six axle articulated (AASHTO Truck Type 1 (Composite): 150/day in 2026, grown to 2029)	TRDT — triaxle, dual tyres	33.6	31.0	108%	over by 8%
Class 8 - Five axle articulated (AASHTO Truck Type 2: 125/day in 2026, grown to 2029)	SAST — single axle, single tyres	5.9	5.5	107%	over by 7%
Class 8 - Five axle articulated (AASHTO Truck Type 2: 125/day in 2026, grown to 2029)	TADT — tandem axle, dual tyres	21.8	22.0	99%	within
Class 8 - Five axle articulated (AASHTO Truck Type 2: 125/day in 2026, grown to 2029)	TADT — tandem axle, dual tyres	21.8	22.0	99%	within
Class 8 - Five axle articulated (AASHTO Truck Type 3: 125/day in 2026, grown to 2029)	SAST — single axle, single tyres	5.9	5.5	107%	over by 7%
Class 8 - Five axle articulated (AASHTO Truck Type 3: 125/day in 2026, grown to 2029)	TADT — tandem axle, dual tyres	11.8	22.0	54%	within
Class 8 - Five axle articulated (AASHTO Truck Type 3: 125/day in 2026, grown to 2029)	TADT — tandem axle, dual tyres	11.8	22.0	54%	within

The heaviest axle group is the TRDT (triaxle, dual tyres) of the Class 9 - Six axle articulated at **33.6 t (329 kN)**, 8% above the legal limit of 31.0 t. **33% of the axle group passes are above the legal limits**, so the design reflects the actual (overloaded) traffic, not the legal loads.

Concrete pavements are relatively insensitive to the number of load repetitions but very sensitive to the magnitude of the axle loads (Section 9.3.4): a modest increase in an axle load causes a large reduction in the allowable repetitions in fatigue and erosion. In the design every axle load is multiplied by the load safety factor of the project reliability (1.30), so the 329 kN group is checked at 428 kN. Where overloading is common, axle load survey data should be used, and enforcement of the legal limits protects the pavement.

Contribution of each axle group type to the damage at the design base thickness of 265 mm:

Axle group type	Fatigue damage	Erosion damage
TADT — tandem axle, dual tyres	0.0%	48.4%
TRDT — triaxle, dual tyres	0.0%	46.5%
Total	**0.0%**	**94.9%**

The design thickness is governed by erosion; both totals are within 100%.

3. PAVEMENT DESIGN PARAMETERS

The design parameters adopted for the concrete pavement are presented in the following sub-sections.

3.1 Design Period

A design period of **20 years** has been adopted (Table 7.2 gives typical design periods; 30–40 years for rigid pavements).

3.2 Subgrade and Subbase

A subgrade design CBR of **20%** has been adopted on a subbase of **150 mm lean-mix concrete (LCS)**. The effective subgrade CBR is **75.0%** (Figure 9.1, 150 mm lean-mix concrete (LCS) line: 10.356 x CBR^1.2105 (CBR limited to 15%, the end of the chart), limited to the maximum permitted 75%). The soil investigation results are given in Annexure D.

3.3 Concrete

A 28-day characteristic flexural strength of **4.5 MPa** has been adopted for the base concrete (Plain concrete (PCP), undowelled joints).

3.4 Project Reliability and Load Safety Factor

A project reliability of **95%** has been adopted, giving a load safety factor of **1.30**. The axle loads are multiplied by this factor in the fatigue and erosion analysis.

3.5 Shoulders

Integral, structural or tied concrete shoulders (or kerbs) are provided, so the coefficients with a concrete shoulder are used.

4. COMPUTATION OF BASE THICKNESS

The base thickness is determined with the design parameters of parts 2 and 3 of this report. The detailed calculations, including the fatigue and erosion damage of each axle group type, are given in Annexure B.

4.1 Fatigue and Erosion Analysis

Item	Value
Least thickness with fatigue and erosion ≤ 100%	264 mm
Rounded up to 5 mm	265 mm
Minimum base thickness (Table 9.7)	200 mm
Design base thickness	**265 mm**
Additional thickness for construction	0 mm
Specified base thickness	**265 mm**
Total fatigue / erosion at the design thickness	0.0% / 94.9%

Result: **PASSES**.

4.2 Comparison of Base Types

Each base type was designed for the same traffic, subgrade, subbase and reliability with its own coefficients, load safety factor and minimum thickness. The rank is a screening; the choice also considers construction, ride quality and maintenance.

Base type	Base (mm)	Minimum (mm)	Fatigue / erosion	Cost per km	Result	Rank
PCP undowelled	265	200	0% / 95%	–	**PASSES**	4
PCP dowelled	190	180	0% / 90%	–	**PASSES**	★ 1
JRCP	190	180	0% / 90%	–	**PASSES**	★ 1
CRCP	190	180	0% / 90%	–	**PASSES**	★ 1
SFCP	265	180	0% / 95%	–	**QUALIFIED** (calculated design outside the validated range)	5

4.3 Recommended Pavement

Based on the design traffic and subgrade parameters set out in this report, the following concrete pavement is recommended:

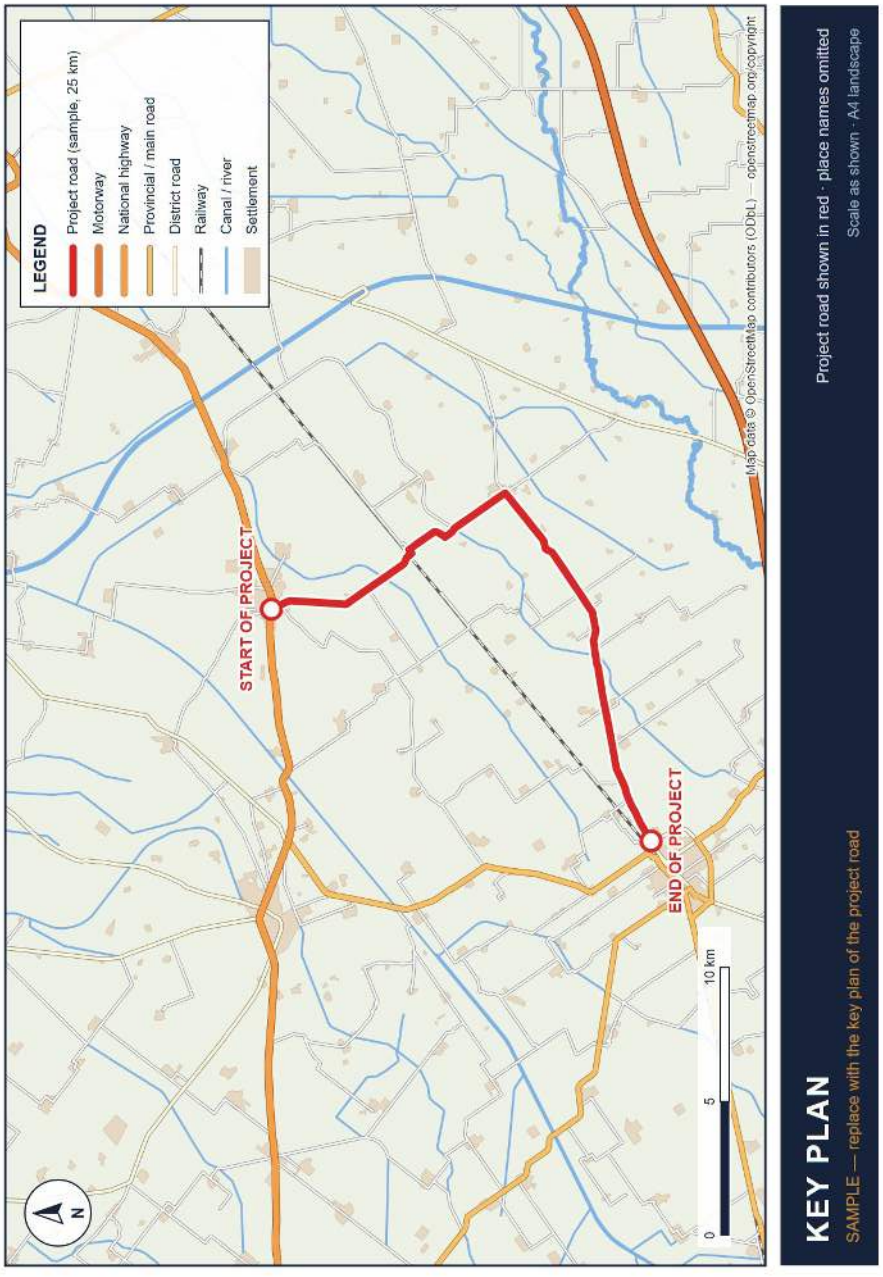
Pavement layer	Thickness (mm)
Plain concrete (PCP), undowelled joints	265
150 mm lean-mix concrete (LCS)	150

Design traffic 1.29×10^{7} heavy vehicle axle groups (HVAG); subgrade design CBR 20% (effective CBR 75.0% on the subbase); concrete flexural strength 4.5 MPa; project reliability 95% (load safety factor 1.30). Total fatigue 0.0% and erosion 94.9% at the design thickness: **PASSES**.

The pavement layers are drawn to scale in Annexure C (Typical Cross Sections), and the detailed design calculations are given in Annexure B.

ANNEXURE – A (KEY PLAN AND LOCATION MAP)

Referred to in: Executive Summary, 1.1 General.



Sample key plan — insert the actual key plan and location map of the project road to replace this sample (upload it in the report form under Annexure A; use + Add plan for more). Map data © OpenStreetMap contributors (ODbL).

ANNEXURE – B (DESIGN CALCULATIONS BY AUSTROADS AGPT02-26)

Referred to in: Executive Summary, 4. Computation of Base Thickness, 4.3 Recommended Pavement.

Full printout of the Austroads Rigid Pavement Design tool, corresponding to the design summarised above.

Report information

Design guide	Austroads AGPT02-26, Guide to Pavement Technology Part 2: Pavement Structural Design (Edition 5.2), Chapter 9 and Section 12.9
Tool build	Rigid APD 2026-10-20
Input checksum	bff8802e (FNV-1a of all inputs)
Traffic load data	Traffic load distribution: your vehicle list, every axle group at its load (4.30E+06 heavy vehicles in the design lane).
Generated	11/5/2026, 12:17:17 PM
Review status	**Not reviewed.** Calculation output only — it must be checked and approved by a qualified pavement engineer before use.

1. Design traffic

Design period	20 years	Growth rate	3%
Direction factor	1	Lane distribution factor	1

Heavy vehicles and axle loads

#	Vehicle	Description	Per day (two-way)	Axle groups (kN)
1	Class 9 - Six axle articulated	AASHTO Truck Type 1 (Composite): 150/day in 2026, grown to 2029	164	SAST 53.4; TADT 186.8; TRDT 329.2
2	Class 8 - Five axle articulated	AASHTO Truck Type 2: 125/day in 2026, grown to 2029	137	SAST 57.8; TADT 213.5; TADT 213.5
3	Class 8 - Five axle articulated	AASHTO Truck Type 3: 125/day in 2026, grown to 2029	137	SAST 57.8; TADT 115.7; TADT 115.7

Heavy vehicles / day, two-way
438

Axle groups per HV, N_{HVAG}
3.00

ESA per axle group
3.634

ESA per heavy vehicle (average damage factor)
10.903

Cumulative HV, design lane
4.30×10^{6}

Design traffic $N_{DT,HVAG}$
1.29×10^{7} HVAG

Design traffic DESA (information)
4.68×10^{7} ESA

```
n (Eq 30)   = 438.0 HV/day × DF 1 × LDF 1 = 438.0 HV/day in the design lane
CGF (Eq 31) = ((1 + 0.01×3)^20 − 1) / (0.01×3) = 26.87
N_DT (Eq 32) = 365 × 26.87 × 438.0 = 4.30E+06 heavy vehicles
```

```
N_DT,HVAG (Eq 35) = 4.30E+06 × 3.000 = 1.29E+07 axle groups   <- design traffic of the concrete pavement
Damage factor: ESA of an axle group = (load / standard load)^4 (Eq 37); per vehicle = sum of its groups; average = Σ(HV/day × ESA/vehicle) ÷ Σ HV/day = 4,775.4 ÷ 438.0 = 10.903 ESA per heavy vehicle
DESA (Eq 38) = 3.6343 ESA/HVAG × 1.29E+07 = 4.68E+07 ESA   (information: the concrete design uses the axle groups and their loads, not ESA)
```

Traffic load distribution: your vehicle list, every axle group at its load (4.30E+06 heavy vehicles in the design lane). Each load is multiplied by the load safety factor in Step 2 (Section 9.3.6). The ESA figures (vehicle table, DESA) are the flexible-pavement measure of the same traffic, shown for comparison; the concrete design uses the axle groups and their loads (Section 9.3.4).

2. Concrete base thickness (Section 9.4)

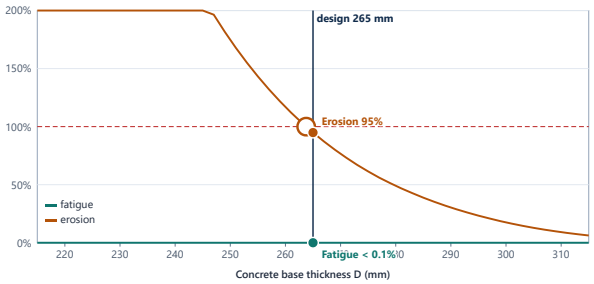
Base type	Plain concrete (PCP), undowelled joints	Concrete shoulder	yes
Subgrade design CBR	20%	Subbase	150 mm lean-mix concrete (LCS)
Effective subgrade CBR	75.0% (Figure 9.1, 150 mm lean-mix concrete (LCS) line: 10.356 x CBR^1.2105 (CBR limited to 15%, the end of the chart), limited to the maximum permitted 75%)	Flexural strength f_{cf}	4.5 MPa
Project reliability	95%	Load safety factor	1.30
Design traffic	1.29×10^7 HVAG	Design route	Chapter 9 (fatigue and erosion)

✓ **Design base thickness 265 mm** — total fatigue 0.0% and erosion 94.9%, both within 100%.

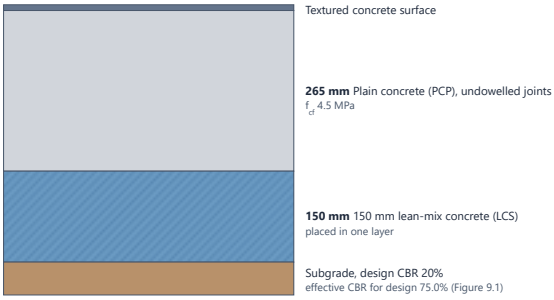
Design traffic	Effective subgrade CBR	Load safety factor	Fatigue / erosion at design
1.29×10^7 HVAG	**75.0%**	**1.30**	**0.0% / 94.9%**

Design base thickness	Specified for construction	Result
265 mm	**265 mm**	**OK**

```
Effective subgrade CBR: Figure 9.1, 150 mm lean-mix concrete (LCS) line: 10.356 x CBR^1.2105 (CBR limited to 15%, the end of the chart), limited to the maximum permitted 75% = 75.00%
Load safety factor: Table 9.2, PCP row, 95% = 1.3
Coefficients: Table 9.4 (stress) and Table 9.5 (undowelled), with concrete shoulder; F2 = 0.94
Least thickness with fatigue <= 100% and erosion <= 100% (1 mm steps): 264 mm -> rounded up to 5 mm: 265 mm
Minimum base thickness (Table 9.7): 200 mm -> design base thickness 265 mm (governed by erosion)
Specified thickness = 265 + 0 mm additional = 265 mm
```



Total fatigue and erosion damage against base thickness; the dashed red line is 100%.



Concrete base and subbase to scale. Joints, dowels and steel: Step 3.

Cross-section of the design.

▼ Damage by axle group type and load at 265 mm (as Appendix M, Tables M.6–M.10)

Single axle, single tyres (SAST) — equivalent stress S_e 0.530 MPa, erosion factor F_3 1.596

Axle group load (kN)	Design load × LSF (kN)	Expected repetitions	Allowable, fatigue	Fatigue damage (%)	Allowable, erosion	Erosion damage (%)
57.8	75.2	1,343,653	Unlimited	0.00	Unlimited	0.00
57.8	75.2	1,343,653	Unlimited	0.00	Unlimited	0.00
53.4	69.4	1,608,461	Unlimited	0.00	Unlimited	0.00
Total SAST				**0.00**		**0.00**

Tandem, dual tyres (TADT) — equivalent stress S_e 0.653 MPa, erosion factor F_3 2.248

Axle group load (kN)	Design load × LSF (kN)	Expected repetitions	Allowable, fatigue	Fatigue damage (%)	Allowable, erosion	Erosion damage (%)
213.5	277.6	1,343,653	Unlimited	0.00	5,798,609	23.17
213.5	277.6	1,343,653	Unlimited	0.00	5,798,609	23.17
186.8	242.9	1,608,461	Unlimited	0.00	78,104,439	2.06
115.7	150.4	1,343,653	Unlimited	0.00	Unlimited	0.00
115.7	150.4	1,343,653	Unlimited	0.00	Unlimited	0.00
Total TADT				**0.00**		**48.40**

Triaxle, dual tyres (TRDT) — equivalent stress S_e 0.520 MPa, erosion factor F_3 2.264

Axle group load (kN)	Design load × LSF (kN)	Expected repetitions	Allowable, fatigue	Fatigue damage (%)	Allowable, erosion	Erosion damage (%)
329.2	427.9	1,608,461	Unlimited	0.00	3,459,986	46.49
Total TRDT				**0.00**		**46.49**

Traffic load distribution: your vehicle list, every axle group at its load (4.30E+06 heavy vehicles in the design lane). Subgrade CBR above 15%: Figure 9.1 ends at 15%, so 15% is used for the effective strength. Effective CBR limited to the maximum permitted 75% (Figure 9.1). Thicknesses are minimum design values; add construction tolerance (Section 9.4.1).

Damage by axle group type at 265 mm

Single axle, single tyres (SAST) — equivalent stress S_e 0.530 MPa, erosion factor F_3 1.596

Axle group load (kN)	Design load × LSF (kN)	Expected repetitions	Allowable, fatigue	Fatigue damage (%)	Allowable, erosion	Erosion damage (%)
57.8	75.2	1,343,653	Unlimited	0.00	Unlimited	0.00
57.8	75.2	1,343,653	Unlimited	0.00	Unlimited	0.00
53.4	69.4	1,608,461	Unlimited	0.00	Unlimited	0.00
Total SAST				**0.00**		**0.00**

Tandem, dual tyres (TADT) — equivalent stress S_e 0.653 MPa, erosion factor F_3 2.248

Axle group load (kN)	Design load × LSF (kN)	Expected repetitions	Allowable, fatigue	Fatigue damage (%)	Allowable, erosion	Erosion damage (%)
213.5	277.6	1,343,653	Unlimited	0.00	5,798,609	23.17
213.5	277.6	1,343,653	Unlimited	0.00	5,798,609	23.17
186.8	242.9	1,608,461	Unlimited	0.00	78,104,439	2.06
115.7	150.4	1,343,653	Unlimited	0.00	Unlimited	0.00
115.7	150.4	1,343,653	Unlimited	0.00	Unlimited	0.00
Total TADT				**0.00**		**48.40**

Triaxle, dual tyres (TRDT) — equivalent stress S_e 0.520 MPa, erosion factor F_3 2.264

Axle group load (kN)	Design load × LSF (kN)	Expected repetitions	Allowable, fatigue	Fatigue damage (%)	Allowable, erosion	Erosion damage (%)
329.2	427.9	1,608,461	Unlimited	0.00	3,459,986	46.49
Total TRDT				**0.00**		**46.49**

3. Joints, dowels, tie bars and reinforcement

Item	Requirement / result	Reference
Transverse joints	Slabs typically 4.2 m long with undowelled skewed transverse joints (corner angles not less than 84°); use these as upper limits on length.	9.2.1
Longitudinal joints	Slab width about 4.3 m or less; all longitudinal joints tied, total tied width at most 16 m. Untied joints count as "with shoulder" only 2 m or more outside a traffic lane.	9.2.1, 9.3.5
Tie bars	12 mm Grade 500N deformed bars, 1 m long, centred in the joint. Equation 62: A_s = 1.5 × 3.6 × 2400 × 9.81 × 265 / (1000 × 300) = **112.3 mm²/m** → spacing about **1,000 mm** (16 mm bars may be used to widen an impractical spacing). Indicative only: the guide refers to the agency standard drawings for the full tie bar design.	9.4.7, Eq 62, Table 9.10
Reinforcement in PCP	Only in discrete areas: odd-shaped or mismatched slabs, slabs with pits or structures, and base anchor slabs.	9.5.2
Anchors	Anchors at terminations against flexible pavements and structures; on grades over about 4%, an intermediate anchor about every 300 m.	9.6
Subbase interlayer	Bond-breaking treatment on the subbase (Table 9.10); a 30 mm dense graded asphalt interlayer is common on bound subbases and is not counted structurally.	9.2.2

Base thickness D used here: 265 mm (specified). Joint detailing (Figures 9.4–9.10) follows the agency standard drawings.

4. Comparison of base types

***Base types: PCP** = plain (jointed unreinforced) concrete pavement, no steel mesh; **JRCP** = jointed reinforced concrete pavement (longer slabs with steel mesh); **CRCP** = continuously reinforced concrete pavement (no contraction joints, continuous longitudinal steel); **SFCP** = steel fibre reinforced concrete pavement (fibres mixed into the concrete). **Dowelled** = steel dowel bars across the transverse joints transfer load between slabs; **undowelled** = no dowels, load passes by aggregate interlock.*

Rank	Base type	Design base (mm)	Governs / status	Steel (t/km)	Construction / km (PKR)	Whole-of-life / km (PKR)	
4	**PCP undowelled** Slabs about 4.2 m with undowelled skewed joints; joints are the main weakness (9.2.1) Designed for your design traffic: 1.29 × 10^7 HVAG	**265** calc 264, min 200	erosion; fatigue 0%, erosion 95%	0.9	missing: Concrete base, 150 mm lean-mix concrete (LCS), Steel (approximate)	missing: rates, PCP undowelled periodic maintenance	in Step 2
★ 1	**PCP dowelled** Slabs about 4.5 m with dowelled square joints (9.2.1) Designed for your design traffic: 1.29 × 10^7 HVAG	**190** calc 189, min 180	erosion; fatigue 0%, erosion 90%	12.4	missing: Concrete base, 150 mm lean-mix concrete (LCS), Steel (approximate)	missing: rates, PCP dowelled periodic maintenance	
★ 1	**JRCP** Mesh-reinforced slabs, dowelled joints 8–10 m apart (9.2.1) Designed for your design traffic: 1.29 × 10^7 HVAG	**190** calc 189, min 180	erosion; fatigue 0%, erosion 90%	22.1	missing: Concrete base, 150 mm lean-mix concrete (LCS), Steel (approximate)	missing: rates, JRCP periodic maintenance	
★ 1	**CRCP** No contraction joints; fine cracks 0.5–2.5 m held by continuous steel; asphalt surfacing cracks least over CRCP (2.2.7) Designed for your design traffic: 1.29 × 10^7 HVAG	**190** calc 189, min 180	erosion; fatigue 0%, erosion 90%	85.1	missing: Concrete base, 150 mm lean-mix concrete (LCS), Steel (approximate)	missing: rates, CRCP periodic maintenance	
5	**SFCP** Undowelled joints at most 6 m; suits odd-shaped slabs, intersections, roundabouts, toll plazas, bus stops (9.2.1, 9.5.3) Designed for your design traffic: 1.29 × 10^7 HVAG	**265** calc 264, min 180	erosion; fatigue 0%, erosion 95% ⚠ **QUALIFIED — not ranked first** Flexural strength 4.5 MPa is below the minimum 5.5 MPa for 10^6 HVAG or more for SFCP (Section 9.3.3).	0.9	missing: Steel fibre concrete base, 150 mm lean-mix concrete (LCS), Steel (approximate)	missing: rates, SFCP periodic maintenance	

Rank (★ = best) is by specified base thickness (fill every rate to rank by cost); qualified designs are never ranked first. Each type is designed with your Step 2 inputs (subbase, shoulder, concrete, reliability, traffic) and its own coefficients, load safety factor and minimum thickness. Steel per km is approximate (tie bars at 4.3 m slab widths, dowels, mesh or continuous steel; no laps,

chairs or wastage) — hover the steel figure for the split. Whole-of-life cost = construction + periodic maintenance + routine maintenance − salvage value, over 20 years at 7% (Equation 67; your maintenance estimates per type).

Choosing between the base types (Austroads AGPT02 Chapters 3 and 10, Sections 2.2.7 and 9.2.1)

Every base type that passes is a feasible design. Austroads advises not to rely on the economic comparison as the sole determinant (Section 10.1). Weigh:

1. **Whole-of-life cost** (Section 10.1): the primary criterion — present worth of construction, maintenance and rehabilitation less salvage value (Equation 67). Routine maintenance of rigid pavements is generally limited to joint and minor structural repairs (Section 10.4). Test the discount rate at 4% and 10% (Section 10.6).
2. **Traffic and use** (Section 2.2.7): rigid pavements suit all urban road classes and moderate to heavily trafficked rural roads, and resist slow, heavy vehicles and fuel spillage. SFCP suits odd-shaped slabs, intersections and roundabouts; CRCP has no contraction joints and gives least cracking under an asphalt surfacing.
3. **Materials available** (Sections 3.2, 3.6): the quality and haul distance of crushed rock, natural gravel and subbase materials, and the supply of cement, lime and bitumen. Stabilisation can make the best use of the materials available and reduce layer thicknesses (Section 3.6); where suitable drainage materials are lacking, use materials that do not weaken unduly when wet (Section 3.2).
4. **Climate and drainage** (Sections 3.2, 3.14.1): in high-rainfall areas or with high groundwater, provide subsurface drainage or a properly designed drainage layer; where that is not possible, keep water out or use bound materials. Soft, moisture-sensitive subgrades (in situ CBR below about 5% at construction) need treatment — drainage, replacement, a working platform or stabilisation (Section 3.14.1).
5. **Construction** (Sections 10.3, 3.4, 3.11): paving plant (slip-form or fixed form), steel fixing for JRCP and CRCP, concrete supply, traffic management, wet-weather delays, establishment and supervision. The pavement type must suit the paving plant available (in remote areas the local equipment decides); when building under traffic, avoid types that need long curing.
6. **Traffic certainty and risk** (Sections 3.5, 3.13): where traffic or funds are uncertain, staged construction may be economical if the first stage suits the later ones (e.g. a base stiff enough for a later asphalt surfacing); take care staging bound layers, whose cracking can reflect into later layers. Prefer designs that are less sensitive to construction conditions: those that need ideal conditions carry a higher risk of early distress.
7. **Other criteria** (Section 10.1): potential differential settlement along the alignment, project scale, building under traffic, noise and spray (surface finish, Part 3), maintenance requirements and sustainability.

Scope and limitations

What this tool designs. The concrete base thickness of new rigid pavements to Austroads AGPT02-26 (Edition 5.2) Chapter 9 (10^6 HVAG or more) and Section 12.9 (lightly trafficked roads), by flexural fatigue of the base and erosion of the subbase / subgrade (Equations 58–61, Tables 9.2–9.7), with indicative dowel, tie bar and reinforcement sizes (Sections 9.4.6–9.5).

- Axle groups covered: SAST, SADT, TAST, TADT, TRDT and QADT. TRST and QAST have no load factors in Equations 58 and 61.
- A final design needs the project axle load distribution; the Austroads example distribution (Appendix F) gives a QUALIFIED, demonstration result. Rigid pavements are very sensitive to overloads: run a sensitivity check (Section 9.3.4).
- Figure 9.1 is used through lines fitted to the printed chart (within about 3% of the guide's own reading; Appendix M reads 75% where the fit gives 72.7%, with the same 215 mm design).
- Not covered: prestressed and roller compacted concrete bases, overlays and rehabilitation, slab dimensions and joint layout beyond the guide's typical values, curling and warping other than through the minimum

thicknesses of Table 9.7, subbase material properties, expansive soils, drainage, and the full design of tie bars and joints (agency standard drawings).

- External inputs not from Austroads (Pakistan NHA axle limits) must be checked against the original agency source.
- Results are calculation output; a qualified pavement engineer must check and approve the design.

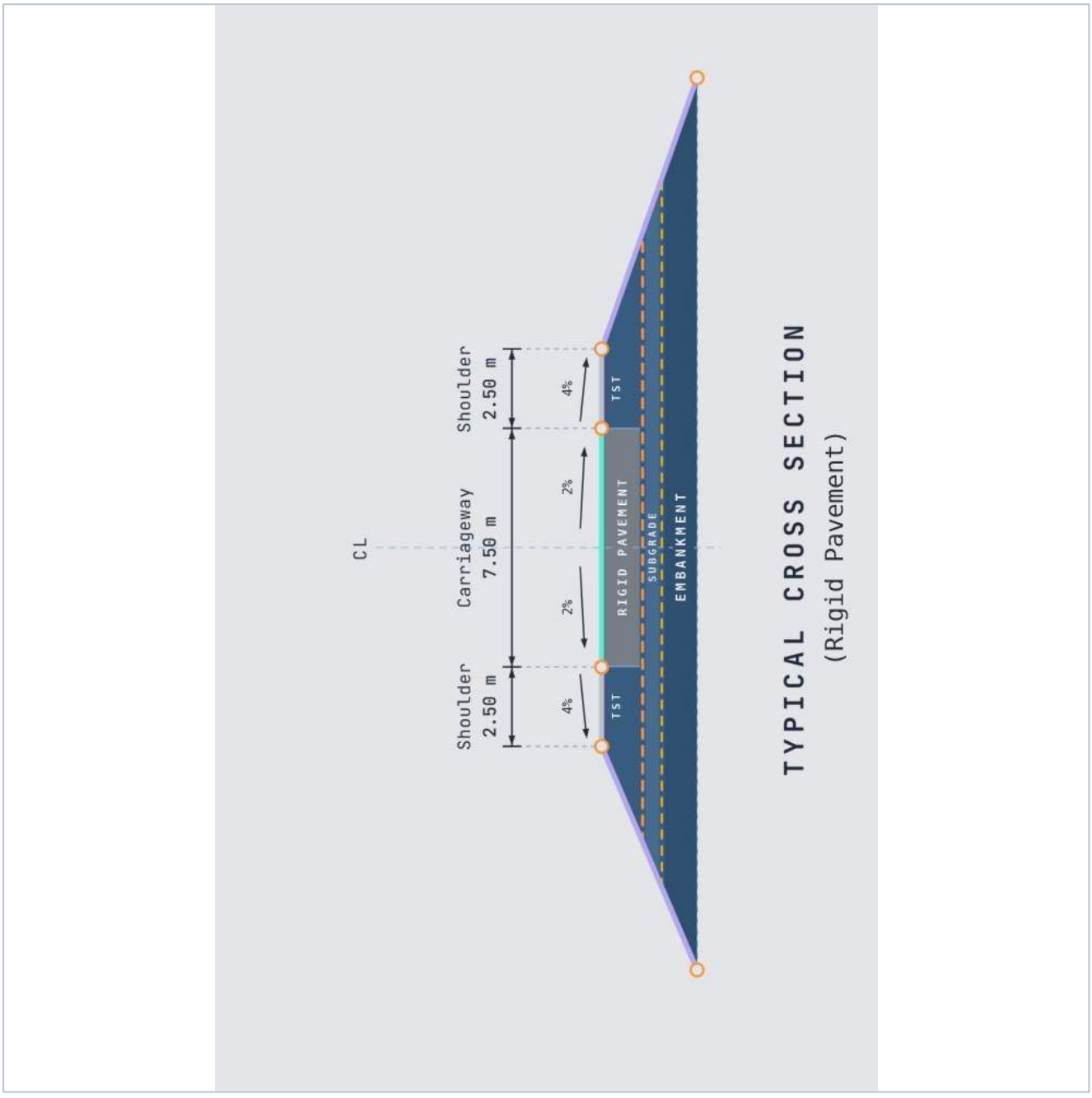
Method and references

- **Design traffic** (Sections 7.4, 7.7, H.3): cumulative heavy vehicle axle groups $N_{DT,HVAG} = N_{DT} \times N_{HVAG}$ (Equations 30–35), split by axle group type and load (traffic load distribution, Section 7.5). In the vehicle mix every axle group of every vehicle is one load; the AADT route uses the Austroads example distribution (Appendix F).
- **Fatigue** (Equations 58–59): $S_r = S_e/(0.944\ f_{cf}) \times (P \cdot LSF / 4.45F_1)^{0.94}$; $\log N_f = (0.9719 - S_r)/0.0828$ for $S_r > 0.55$; $N_f = (4.258/(S_r - 0.4325))^{3.268}$ for $0.45 \le S_r \le 0.55$; unlimited below 0.45. F_1 = 9 SAST, 18 SADT and TAST, 36 TADT, 54 TRDT, 72 QADT.
- **Erosion** (Equation 61): $\log(F_2 N_e) = 14.524 - 6.777\ [\max(0, (P \cdot LSF / 4.45F_4)^2 \cdot 10^{F_3}/41.35 - 9.0)]^{0.103}$; F_2 = 0.06 without and 0.94 with a concrete shoulder; F_4 as F_1 but 54 for QADT.
- **Equivalent stress S_e and erosion factor F_3** (Equation 60) from the base thickness D and the effective subgrade CBR E_f, with the coefficients of Table 9.4 (stress) and Tables 9.5 / 9.6 (erosion, undowelled / dowelled or CRCP).
- **Design thickness** (Table 9.3, Section 9.4.1): the least thickness with total fatigue ≤ 100% and total erosion ≤ 100%, rounded up to 5 mm, not less than the minimum of Table 9.7 (125 mm below 10^6 HVAG, Section 12.9.4). Repetitions with allowable loads above 10^{11} are not counted (Table 9.3 step 13).
- **Effective subgrade strength** (Figure 9.1): the four subbase lines are straight on the log–log chart and are fitted to it ($CBR_E = a \times CBR^k$, maximum 75%); below CBR 2% use 150 mm LCS and 5%. Layered subgrade: Equation 57.
- **Light traffic** (below 10^6 HVAG, Section 12.9): erosion is not normally a distress mode, so only fatigue governs; erosion is still shown.
- **Joints and reinforcement**: dowels Table 9.9 (Grade 250N, 450 mm, 300 mm centres); tie bars and JRCP / CRCP transverse steel by subgrade drag, $A_s = \mu L \rho g D/(1000 f_s)$ (Equation 62); CRCP longitudinal steel Equations 63–65 (minimum 0.67%) and crack spacing Equation 66.
- Verified against the worked example of Appendix M (PCP with shoulders, 150 mm LCS, 4×10^7 HVAG, LSF 1.3): equivalent stresses, erosion factors and allowable repetitions match the printed tables, and the design is 215 mm.
- Source: Austroads (2026) *Guide to Pavement Technology Part 2: Pavement Structural Design*, AGPT02-26 (Edition 5.2), Chapters 7, 9 and 12, Appendices F, H and M. This free tool is independent and not endorsed by Austroads; check designs against the guide and your road agency's requirements.

Generated with the free Austroads Rigid Pavement Design tool at shahidpervaiz.net. Results must be checked by a qualified pavement engineer.

ANNEXURE – C (TYPICAL CROSS SECTIONS)

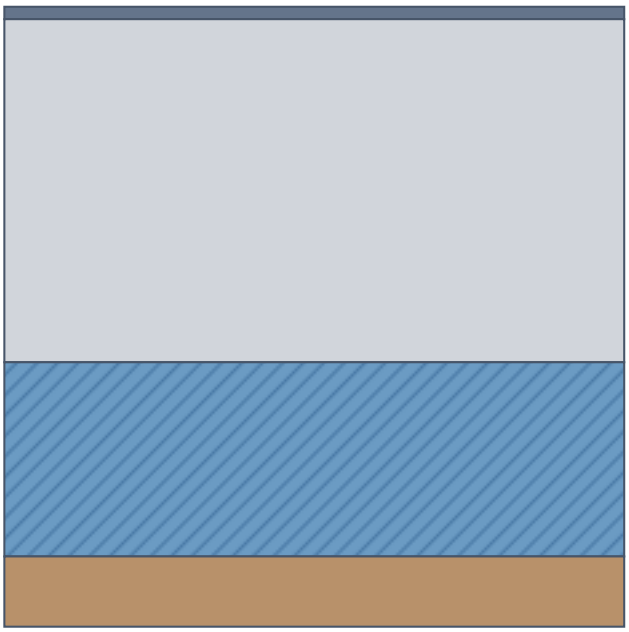
Referred to in: Executive Summary, 4.3 Recommended Pavement.



Sample drawing — insert the actual project cross section to replace this sample (upload it in the report form under Annexure C; use + Add cross section for more sections).

Pavement layers (to scale)

Pavement section drawn to scale by the tool (thicknesses in mm).



Textured concrete surface

265 mm Plain concrete (PCP), undowelled joints
f_{cf} 4.5 MPa

150 mm 150 mm lean-mix concrete (LCS)
placed in one layer

Subgrade, design CBR 20%
effective CBR for design 75.0% (Figure 9.1)

Concrete base and subbase to scale. Joints, dowels and steel: Step 3.

ANNEXURE – D (SOIL INVESTIGATION RESULTS OF CBR)

Referred to in: Executive Summary, 3.2 Subgrade and Subbase.

A subgrade design CBR of **20%** has been adopted in this design (see part 3.2 of this report).

Full soil and material investigation report, borehole logs and laboratory CBR test results to be attached separately by the design engineer (upload images or PDFs in the report form; + Add report / page for more).

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