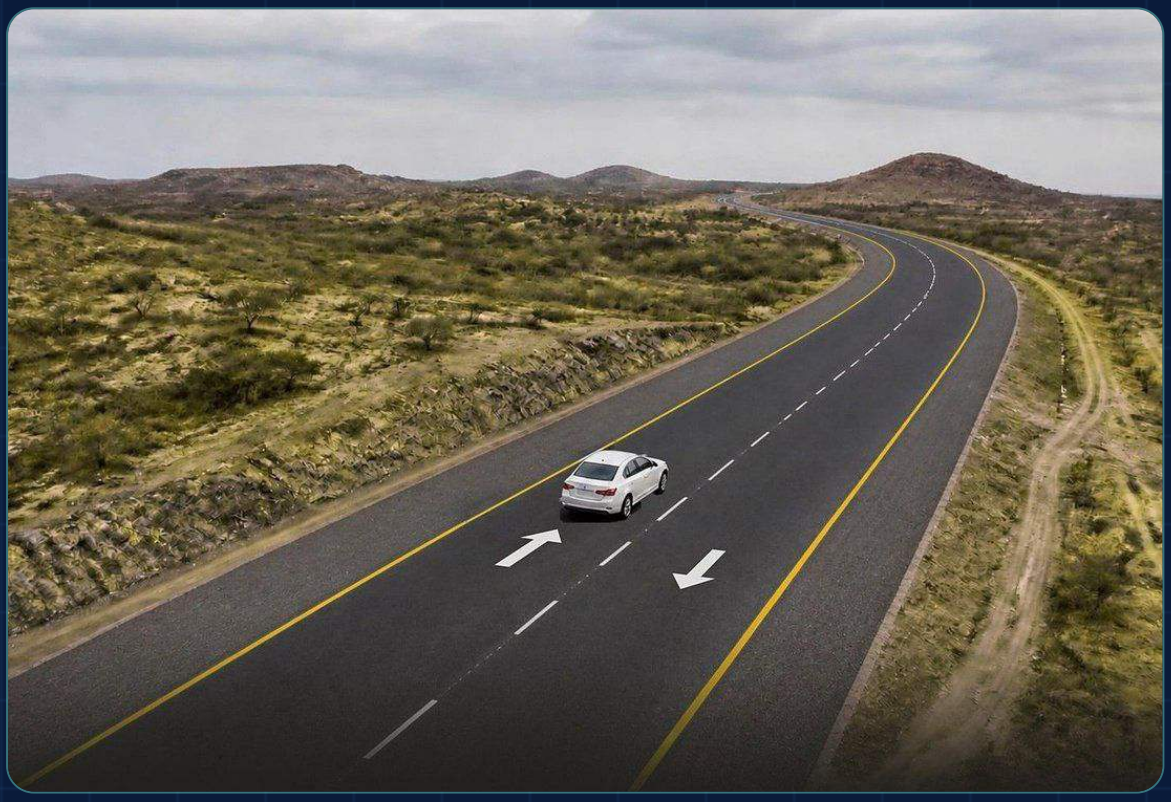
ENGINEERING REPORT

Flexible Pavement Design Report

Based on AASHTO Guide for Design of Pavement Structures, 1993



Sample Road

Client: Highway Authority

PREPARED & SUBMITTED BY

SP Consultant

in Joint Venture with SS Consultant

shahidpervaiz.net

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EXECUTIVE SUMMARY

The proposed project road 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 project road 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 AASHTO Guide for Design of Pavement Structures, 1993, 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.

Design basis. The pavement has been designed with the AASHTO Guide for Design of Pavement Structures, 1993, an empirical method based on the performance of the pavements of the AASHO Road Test. The design traffic is the cumulative number of 80 kN equivalent single axle loads (W_{18}); with the design reliability (Z_R, S_0), the allowable loss of serviceability (ΔPSI) and the resilient modulus of the subgrade (M_R), the design equation gives the required structural number (SN). The thicknesses of the asphalt, base and subbase layers are then chosen so that, with their layer and drainage coefficients, they provide at least the required SN.

The design of the pavement structure includes selecting materials of adequate strength and placing them at the proper thickness, density and depth, so that the pavement is capable of carrying the anticipated number of load repetitions over its design life while meeting the safety and serviceability requirements to avoid distress during the design life of the pavement.

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

Pavement Layer	Thickness (cm)
Asphalt Concrete Wearing Course	7.00
Asphalt Concrete Base Course	16.00
Aggregate Base Course	15.00
Granular Subbase Course	25.00

Provided structural number, ΣSN = **5.75**, against a required structural number of **4.51** — status: **ADEQUATE margin +1.24**.

The Assessment of ESALs — covering input data, traffic projection, axle load equivalency factors (EALFs) from AASHTO 1993 Appendix D, and year-by-year cumulative ESAL calculation — is presented in Section 2 of this report. The key plan and location map are included as Annexure A, the pavement design calculations by AASHTO 1993 in

Annexure B, proposed typical cross sections in Annexure C, and soil investigation results of CBR in Annexure D of this report.

1. INTRODUCTION

1.1 General

The proposed project road 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.

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The pavement design has been developed in accordance with the AASHTO Guide for Design of Pavement Structures, 1993, 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.

2. ASSESSMENT OF ESALS

The traffic loading for pavement design is expressed as the cumulative number of Equivalent Standard Axle Loads (ESALs) over the design period. ESALs are calculated in accordance with the AASHTO Guide for Design of Pavement Structures, 1993, by applying Load Equivalency Factors (LEFs) derived from Appendix D (Tables D.1–D.9) to each vehicle type and axle group in the traffic fleet, using the axle configuration, loads, and Adopted design factors set out in the ESAL Calculator.

2.1 Input Data

Traffic & Project Parameters	
Project	**Sample Road**
Traffic count year (base year)	2026
Construction completion year	2029
Projected year for pavement design	2049
Design life	20 years (after opening to traffic)
Pre-construction period	3 years
Total analysis period (n)	**23 years**
Annual traffic growth rate (g)	3% per year
AASHTO LEF Interpolation Parameters	
Structural Number (SN) assumed for LEF lookup	4
Terminal Serviceability Index (P_t) for LEF lookup	2.5
Growth Factor	
Growth Factor formula	$GF = [(1 + g/100)^n - 1] / (g/100)$
Growth Factor, GF	**26.87**

2.2 Equivalent Axle Load Factors (EALFs)

Load Equivalency Factors (LEFs) for each axle group are obtained from AASHTO 1993 Appendix D by bilinear interpolation on axle load (kips) and Structural Number (SN = **4**), with linear interpolation on the Terminal Serviceability Index (P_t = **2.5**). Table references: D.1–D.2 for single axles, D.3–D.4 for tandem axles, D.5–D.6 for tridem axles. The composite LEF for each truck type is the sum of its individual axle LEFs (Total column below). Where the composite LEF has been increased to allow for unchecked overloading, the Adopted value governs that truck type's Daily ESALs.

Truck Type		Front Axle	Mid. Axle	Rear1 Axle	Rear2 Axle	Total	Adopted	AADT	Daily ESAL
Truck Type 1 (Composite)	Axle Type	Single	Tandem	Triple	—				
	Load Kips	12.00	42.00	74.00	—	**128.00**			
	LEF (AASHTO)	0.21	2.43	5.32	—	**7.96**	**7.96**	150	**1,194**
Truck Type 2	Axle Type	Single	Tandem	Tandem	—				
	Load Kips	13.00	48.00	48.00	—	**109.00**			
	LEF (AASHTO)	0.30	3.98	3.98	—	**8.26**	**8.26**	125	**1,033**
							Total Daily ESAL		**2,365**

Truck Type		Front Axle	Mid. Axle	Rear1 Axle	Rear2 Axle	Total	Adopted	AADT	Daily ESAL
Truck Type 3	Axle Type	Single	Tandem	Tandem	—				
	Load Kips	13.00	26.00	26.00	—	**65.00**			
	LEF (AASHTO)	0.30	0.40	0.40	—	**1.10**	**1.10**	125	**138**
								Total Daily ESAL	**2,365**

2. ASSESSMENT OF ESALS (CONTINUED)

2.3 Cumulative ESALs (AASHTO Method)

The Total Daily ESAL of the fleet (both directions, previous page) is annualised (×365 days) and grown at 3% a year from the traffic count year 2026 to the opening year 2029, $(1+g)^p = 1.093$. It is then accumulated over the 20-year design life with the growth factor $GF = [(1+g)^n - 1]/g$ and multiplied by the directional distribution factor DDF = 1 and the lane distribution factor LDF = 1 (AASHTO 1993, Part II, 2.1.3) to give the design-lane ESALs, W_{18}: W_{18} = annual ESAL × $(1+g)^p$ × GF × DDF × LDF. Traffic during construction is not design traffic.

Total Daily ESAL	2,365
Total Annual ESAL	863,161
Growth to the opening year, $(1+g)^p$	1.093
Growth Factor over the design life, GF	26.87
Design lane factor, DDF × LDF	1 × 1 = 1.00
Design-lane ESALs over the design life, W_{18}	**25,344,123 (25.34 million)**

For the project road, a design ESAL, W_{18}, of **25.34 million** has been adopted, corresponding to $\log_{10}(W_{18})$ = **7.4039**.

2.4 Axle Loads and Their Effect on the Pavement

The axle loads of the truck fleet 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). The last two columns give the AASHTO load equivalency factor (LEF) of each axle with the load as entered and, estimated, with the load capped at the legal limit.

Truck	Axle	Load (kips)	Load (t)	Legal limit (t)	Load / limit	Status	LEF as entered	LEF at the legal limit (est.)
Truck Type 1 (Composite)	front single axle	12.00	5.4	5.5	99%	within	0.21	0.21
Truck Type 1 (Composite)	tandem axle	42.00	19.1	22.0	87%	within	2.43	2.43
Truck Type 1 (Composite)	tridem (triple) axle	74.00	33.6	31.0	108%	over by 8%	5.32	3.87
Truck Type 2	front single axle	13.00	5.9	5.5	107%	over by 7%	0.30	0.23
Truck Type 2	tandem axle	48.00	21.8	22.0	99%	within	3.98	3.98
Truck Type 2	tandem axle	48.00	21.8	22.0	99%	within	3.98	3.98
Truck Type 3	front single axle	13.00	5.9	5.5	107%	over by 7%	0.30	0.23
Truck Type 3	tandem axle	26.00	11.8	22.0	54%	within	0.40	0.40
Truck Type 3	tandem axle	26.00	11.8	22.0	54%	within	0.40	0.40

The heaviest axle is the tridem (triple) axle of the Truck Type 1 (Composite) at **33.6 t**, 8% above the legal limit of 31.0 t. **33% of the axle passes are above the legal limits.**

In the AASHTO method the load equivalency factors (Appendix D, flexible pavement tables, depending on the structural number SN and the terminal serviceability p_t) rise with roughly the fourth power of the axle load, as observed in the AASHO Road Test: an axle 10% over the limit does about 1.46 times the damage of a legal one, and 20% over about 2.07 times. With the loads as entered the fleet gives **2,365 ESALs per day**, against an estimated 2,129 ESALs per day if every axle carried no more than its legal limit: **overloading increases the design ESALs by about 11%**.

Share of the ESALs by truck: Truck Type 1 (Composite) 51%, Truck Type 2 44%, Truck Type 3 6%.

Axle load survey data should be used where available, and enforcement of the legal limits protects the pavement.

3. PAVEMENT DESIGN PARAMETERS

The AASHTO Design Guide for Pavement Structures, 1993, has been used for the purpose of the pavement design. The design parameters adopted for the project road are presented in the following sub-sections. Traffic loading expressed as Design ESALs (W_{18}) is presented in Section 2 of this report.

3.1 Direction Distribution Factor

The Directional Distribution Factor (DDF) represents the proportion of the total two-way traffic that is expected to travel in the design direction. It is an important consideration in pavement design because the traffic volume recorded on a two-way road includes vehicles travelling in both directions, whereas the pavement structure is generally designed based on the traffic loading carried by the critical or design direction.

The project road has been assessed for directional traffic distribution. A Directional Distribution Factor of **1.00** has been adopted for the calculation of design ESALs. The project road is a two-lane single carriageway, with one lane provided for traffic in each direction. In the absence of specific directional traffic count data indicating a significant difference between the two directions, an equal distribution of traffic has been assumed.

3.2 Lane Distribution Factor

The Lane Distribution Factor (LDF) represents the proportion of the traffic travelling in a given direction that is assigned to the design lane. This factor is particularly important for multilane highways, where traffic in the same direction may be distributed among two or more lanes.

A Lane Distribution Factor of **1.00** has been adopted for the calculation of design ESALs. The project road is a two-lane single carriageway, with one traffic lane provided in each direction. Therefore, all traffic travelling in the respective direction is carried by a single lane, and no further distribution of traffic between lanes is required.

3.3 Design Life

The design life is the period for which the pavement structure is designed to provide adequate structural capacity and acceptable serviceability under the anticipated traffic and environmental conditions, without requiring major structural rehabilitation.

The design life is an important parameter in the AASHTO pavement design procedure because the cumulative traffic loading over this period directly influences the required Structural Number (SN) and pavement layer thicknesses.

A design life of **20 years** has been adopted for the pavement structure, from a construction completion year of 2029 to a projected design year of 2049. The pavement layer thicknesses have therefore been determined to provide the required structural capacity for the anticipated cumulative traffic loading over this design period.

3.4 California Bearing Ratio (CBR)

The California Bearing Ratio (CBR) is a widely used index of the strength and bearing capacity of unbound pavement materials, including the subgrade, subbase and base course materials. The CBR test provides an empirical measure of the resistance of a material to penetration and is commonly used in pavement investigation and design.

The CBR test involves obtaining representative samples from the field and testing them under controlled laboratory conditions. The results are used directly in empirical pavement design methods or, where required, are correlated with other engineering properties such as the Resilient Modulus (M_R).

A CBR of **20.00%** has been adopted for the design subgrade, and the corresponding resilient modulus has been estimated using the adopted CBR–M_R relationship (see Section 3.5).

3.5 Modulus of Resilience

For the AASHTO 1993 pavement design procedure, the Resilient Modulus (M_R) is used to characterize the stiffness and load-supporting capacity of the subgrade. The AASHTO 1993 Guide provides the commonly used relationship M_R = 1,500 × CBR, which is generally applicable for subgrade materials having CBR values of 10% or less.

Since the adopted subgrade CBR for the project is **20.00%**, this relationship is not considered appropriate, and an alternative empirical correlation, based on TRRL guidance and previous pavement design experience for National Highways, has been adopted instead:

$$M_R = 2{,}555 \times CBR^{0.64}$$

$$M_R = \mathbf{17380.01\ psi}$$

Accordingly, a Resilient Modulus (M_R) of **17380.01 psi** has been adopted for the subgrade in the AASHTO 1993 pavement design calculations.

3.6 Reliability (R)

Design Reliability (R) represents the degree of confidence that the pavement structure will perform satisfactorily throughout the selected design period under the anticipated traffic and environmental conditions. The appropriate reliability level is selected based on the functional classification of the roadway, traffic importance, and whether the facility is located in an urban or rural area.

A design reliability level of **95 %** has been adopted. The corresponding standard normal deviate (Z_R) of **-1.645** is used in the AASHTO 1993 design equation for the selected reliability level.

Functional Classification	Reliability — Urban (%)	Reliability — Rural (%)
Interstate and other Freeways	85–99.9	80–99.9
Principal Arterial	80–99	75–95
Collectors	80–95	75–95
Local	50–80	50–80

3.7 Standard Deviation (So)

The overall standard deviation (S_0) accounts for the inherent variability and uncertainty associated with pavement design and performance — the combined effects of variations in material properties, construction quality, traffic estimation, and actual pavement performance relative to the predicted design conditions.

An overall standard deviation of **S_0 = 0.45** has been adopted for the pavement design of the project road, used in conjunction with the adopted reliability level of **95 %**.

3.8 Standard Normal Deviation (ZR)

The recommended values of standard normal deviation (Z_R) by the AASHTO Guide 1993 are given below. The value corresponding to the adopted reliability of **95 %** is **-1.645**, which has been adopted in the design of the project road.

Reliability R (%)	Standard Normal Deviate (ZR)
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	-1.037
90	-1.282
91	-1.340
92	-1.405
93	-1.476
94	-1.555
95	-1.645
96	-1.751
97	-1.881
98	-2.054
99	-2.327
99.9	-3.090
99.99	-3.750

3.9 Performance Criteria

Pavement serviceability represents the ability of the pavement to provide a safe, comfortable and satisfactory level of service to the traffic using the facility. Pavement performance is assessed in terms of the Present Serviceability Index (PSI), representing the overall condition and functional performance of the pavement as perceived by road users.

The AASHTO design procedure uses two principal serviceability parameters: the Initial Serviceability Index (P_0) and the Terminal Serviceability Index (P_t). The difference between these two values, expressed as the allowable loss of serviceability ($\Delta PSI = P_0 - P_t$), is incorporated into the pavement design equation.

3.10 Initial Serviceability Index (Po)

The Initial Serviceability Index (P_0) represents the condition and level of serviceability of the pavement immediately after construction and opening to traffic.

For flexible pavement design, an initial serviceability index of **P_o = 4.20**, as recommended based on the AASHO Road Test, has been adopted for the project road.

3.11 Terminal Serviceability Index (Pt)

The Terminal Serviceability Index (P_t) represents the minimum acceptable level of pavement serviceability at the end of the design period, below which the pavement would generally require major rehabilitation, resurfacing or reconstruction.

A Terminal Serviceability Index (P_t) of **P_t = 2.50** has been adopted. In combination with the adopted Initial Serviceability Index of **4.20**, this results in an allowable serviceability loss (ΔPSI) of **1.70**, incorporated into the AASHTO 1993 pavement design equation.

3.12 Layer Coefficients

The layer coefficient (a) represents the relative structural contribution of a pavement material per unit thickness and is used in the AASHTO 1993 pavement design procedure to determine the overall Structural Number (SN). Layer coefficients are selected based on the material type and its structural properties in accordance with the AASHTO Guide for Design of Pavement Structures, 1993.

Layer coefficients of a_1 = **0.14** (asphalt wearing course), a_2 = **0.17** (asphalt base course), a_3 = **0.055** (aggregate base course) and a_4 = **0.049** (granular subbase course) have been adopted for the design of the project road, as shown in Annexure B.

The layer coefficients are combined with the respective layer thicknesses and drainage coefficients, where applicable, to calculate the Structural Number (SN) using the AASHTO 1993 relationship set out in Section 4 below.

4. COMPUTATION OF REQUIRED PAVEMENT THICKNESSES

The structural number (SN) requirement, as determined through adoption of the design parameters discussed above, is balanced by providing an adequate pavement structure. Once the design structural number (SN) for an initial pavement structure has been determined, a set of pavement layer thicknesses that will provide the required load-carrying capacity corresponding to the design structural number is calculated. Under the AASHTO design procedure, the following equation provides the means for converting the structural number into actual thicknesses of surfacing, base and sub-base materials:

$$SN = a_1D_1 + a_2D_2 + a_3D_3m_2 + a_4D_4m_3$$

The required variable data to be substituted into this equation are:

a_1	asphalt wearing course layer coefficient
a_2	asphalt base course layer coefficient
a_3	aggregate base layer coefficient
a_4	granular subbase layer coefficient
D_1	thickness of asphalt wearing course
D_2	thickness of asphalt base course
D_3	thickness of aggregate base layer
D_4	thickness of granular subbase layer
m_2	drainage coefficient of aggregate base layer
m_3	drainage coefficient of granular subbase layer

This equation does not have a single unique solution. There are many combinations of layer thicknesses that can be adopted to achieve a given structural number.

4.1 Drainage Coefficient (mi)

The drainage coefficient (m_i) is an important parameter in the AASHTO 1993 flexible pavement design procedure and is used to account for the effect of drainage conditions on the structural performance of untreated pavement layers, such as aggregate base and granular subbase. The coefficient reflects the quality of drainage and the length of time the pavement layers are exposed to moisture conditions approaching saturation.

The AASHTO Guide for Design of Pavement Structures, 1993, classifies drainage quality according to the approximate time required for water to be removed from the pavement structure, ranging from Excellent (water removed within

approximately 2 hours) to Very Poor (water does not drain effectively). The appropriate drainage coefficient is then selected based on the drainage quality and the percentage of time the pavement structure is expected to be exposed to moisture levels approaching saturation.

For the project road, drainage coefficients of **m_2 = 1.00** (aggregate base) and **m_3 = 1.00** (granular subbase) have been adopted.

4.2 Pavement Thickness Using AASHTO 1993

The pavement thickness for the project road is calculated using the AASHTO 1993 pavement design guide, as summarized below.

Layer	Layer Coeff.	Drainage Coeff.	Thickness (cm)	SN Achieved	SN Accum.	SN Reqd.
Asphalt Concrete Wearing Course	0.14	—	7.00	0.98	0.98	
Asphalt Concrete Base Course	0.17	—	16.00	2.72	3.70	
Aggregate Base Course	0.055	1.00	15.00	0.82	4.52	
Granular Subbase Course	0.049	1.00	25.00	1.23	5.75	4.51

Provided structural number, ΣSN = **5.75**, against required SN = **4.51** — status: **ADEQUATE margin +1.24**.

Note: this calculator produces a single pavement structure. If the project requires separate designs for multiple road sections, repeat this calculation for each section and present the results as separate subsections (4.2.1, 4.2.2, ...).

4.3 Layered Design Check and Minimum Thicknesses of Pavement Layers

4.3.1 Layered Design Analysis

A flexible pavement is a layered system, and the AASHTO Guide 1993 (Part II, Section 3.1.5 and Figure 3.2) requires it to be designed accordingly. A total structural number equal to the design SN is not sufficient on its own: each layer must also be protected by enough structural capacity above it, so that it is not over-stressed by the traffic. The structural number required over the aggregate base and over the granular subbase is therefore determined with the same design equation and the same design traffic, reliability, standard deviation and serviceability loss as the design SN, but with the elastic modulus of that layer in place of the roadbed soil resilient modulus.

The layer thicknesses must satisfy the following three conditions, where SN_1, SN_2 and SN_3 are the structural numbers required over the aggregate base, over the subbase and over the roadbed soil:

$$a_1D_1 + a_2D_2 \geq SN_1 \quad (M_R = E_{BS})$$

$$a_1D_1 + a_2D_2 + a_3D_3m_2 \geq SN_2 \quad (M_R = E_{SB})$$

$$a_1D_1 + a_2D_2 + a_3D_3m_2 + a_4D_4m_3 \geq SN_3 \quad (M_R = \text{roadbed soil})$$

For the aggregate base, the base modulus has been derived from its layer coefficient (a = 0.140 per inch) with the relationship of Figure 2.6 of the guide, $a = 0.249 \log_{10}E_{BS} - 0.977$, giving **30,531 psi**. For the granular subbase, the subbase modulus has been derived from its layer coefficient (a = 0.124 per inch) with the relationship of Figure 2.7 of the guide, $a = 0.227 \log_{10}E_{SB} - 0.839$, giving **17,552 psi**. As the guide states, the procedure is not applied above a base or subbase with a modulus greater than 40,000 psi; the thicknesses above such a layer are then set by cost effectiveness and the minimum practical thicknesses.

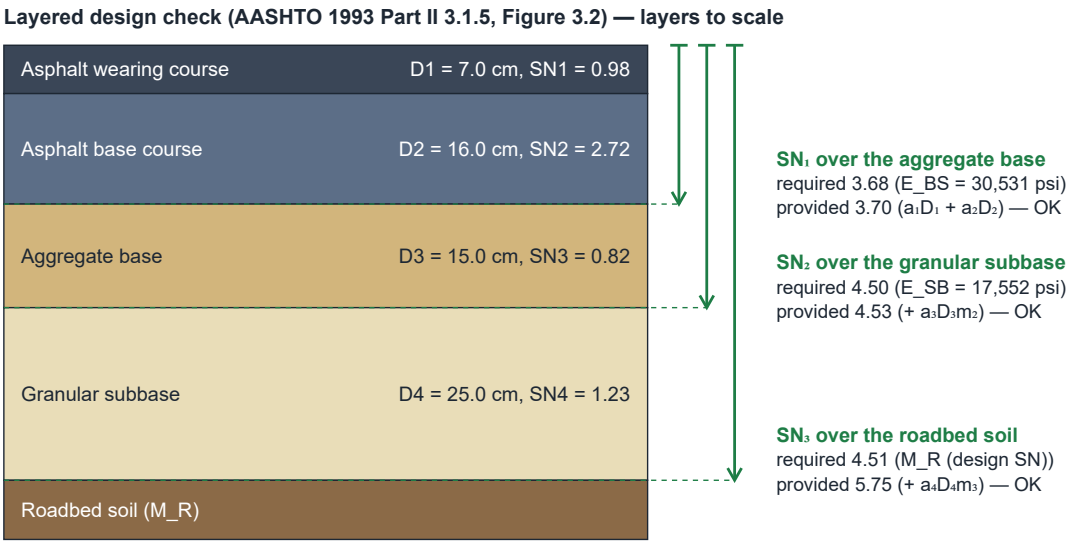


Figure 4.1 — Layered design check of the pavement structure (after AASHTO 1993, Figure 3.2).

Check	Required	Provided	Result
SN over the aggregate base (E = 30,531 psi, from a_3)	3.68	3.70 (asphalt layers)	OK
SN over the granular subbase (E = 17,552 psi, from a_4)	4.50	4.53 (asphalt + base)	OK
SN over the roadbed soil (M_R)	4.51	5.75 (all layers)	OK
Minimum asphalt concrete for 25,340,000 ESALs	4.0 in ≈ 10 cm	9.1 in (23.0 cm)	OK
Minimum aggregate base	6 in ≈ 15 cm	5.9 in (15.0 cm)	OK

The structural number of the asphalt layers, 3.70, against 3.68 required over the aggregate base, is satisfied. The structural number of the asphalt layers and the aggregate base, 4.53, against 4.50 required over the subbase, is satisfied. The total structural number of 5.75, against 4.51 required over the roadbed soil, is satisfied.

4.3.2 Minimum Practical Thicknesses

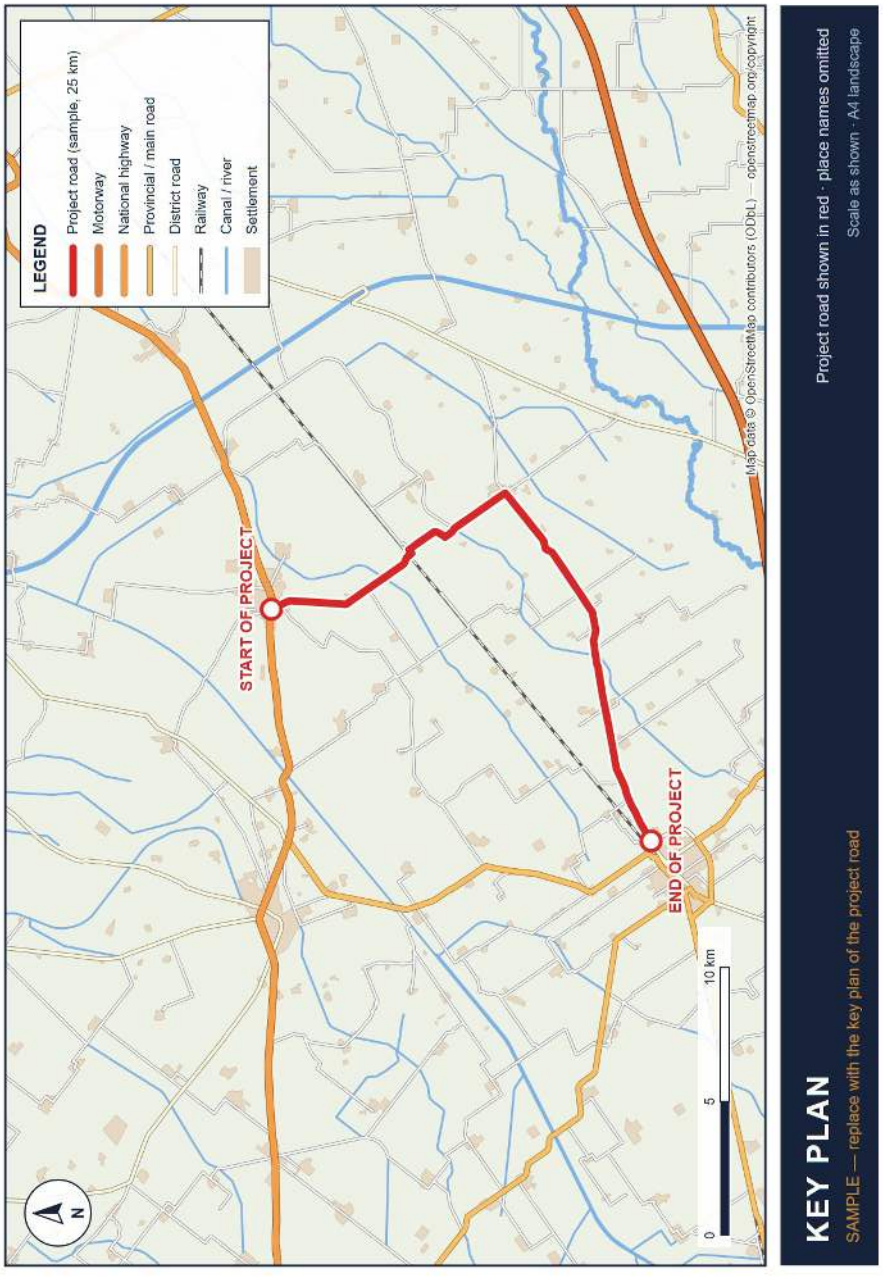
It is generally impractical and uneconomical to place surface, base or subbase courses thinner than a certain minimum, which depends on the traffic. The AASHTO Guide 1993 (Part II, Section 3.1.4) gives the following minimum practical thicknesses; individual agencies may modify them for local practice and conditions. The metric values have been rounded to the nearest centimetre, and the row applicable to the design traffic of the project road is highlighted.

Design traffic, ESALs	Asphalt concrete, in	Aggregate base, in
Less than 50,000	1.0 (3 cm) or surface treatment	4 (10 cm)
50,001 – 150,000	2.0 (5 cm)	4 (10 cm)
150,001 – 500,000	2.5 (6 cm)	4 (10 cm)
500,001 – 2,000,000	3.0 (8 cm)	6 (15 cm)
2,000,001 – 7,000,000	3.5 (9 cm)	6 (15 cm)
Greater than 7,000,000	**4.0 (10 cm)**	**6 (15 cm)**

For the design traffic of **25,340,000 ESALs**, the minimum asphalt concrete thickness is 4.0 in (10 cm) and the minimum aggregate base thickness is 6 in (15 cm). The total asphalt concrete provided, 23.0 cm, satisfies the minimum, and the aggregate base provided, 15.0 cm, satisfies the minimum.

The pavement structure therefore satisfies the layered design analysis and the minimum practical thicknesses of the AASHTO Guide 1993, in addition to the total structural number required.

ANNEXURE – A (KEY PLAN AND LOCATION MAP)



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

ANNEXURE – B (DESIGN CALCULATIONS BY AASHTO 1993)

Full printout of the flexible pavement design calculator, corresponding to the design summarized above.

A. Project Data

Traffic count year	2026
Construction completion year (start)	2029
Projected year for pavement design	2049
Design life	20 yr

B. Design Data

Standard axle weight	18.00 kips
Reliability level, R	95 %
Standard normal deviate, Z_R	-1.645
Overall standard deviation, S0	0.45
Initial serviceability, P0	4.20
Terminal serviceability, Pt	2.50
Serviceability loss, ΔPSI	1.70
Soaked CBR of subgrade	20.00 %
Drainage coefficient — base, m2	1.00
Drainage coefficient — subbase, m3	1.00

C. Traffic & Subgrade Input for SN

Design ESAL, W18	25.34 million
Effective resilient modulus, MR	17380.01 psi
$\log_{10}(W18)$ — left side	7.404

D. Design Structural Number, SN

Design SN (trial value)	4.513
Right side of equation, using Design SN	7.404
Left side vs. right side	MATCH (Δ 0.000)

E. Asphalt Concrete Wearing Course

Thickness, D1	7.00 cm
Layer coefficient, a1	0.14
SN1 = a1 × D1	0.98

F. Asphalt Concrete Base Course

Thickness, D2	16.00 cm
Layer coefficient, a2	0.17
SN2 = a2 × D2	2.72

G. Aggregate Base Course

Thickness, D3	15.00 cm
Layer coefficient, a3	0.055
SN3 = a3 × D3 × m2	0.82

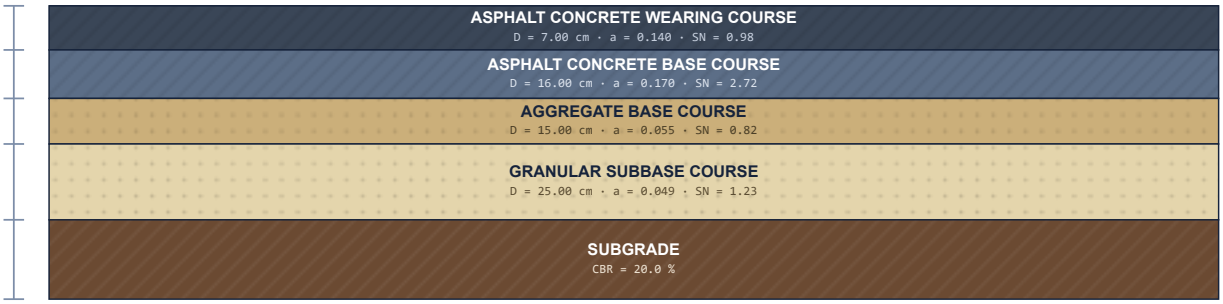
H. Granular Subbase Course

Thickness, D4	25.00 cm
Layer coefficient, a4	0.049
SN4 = a4 × D4 × m3	1.23

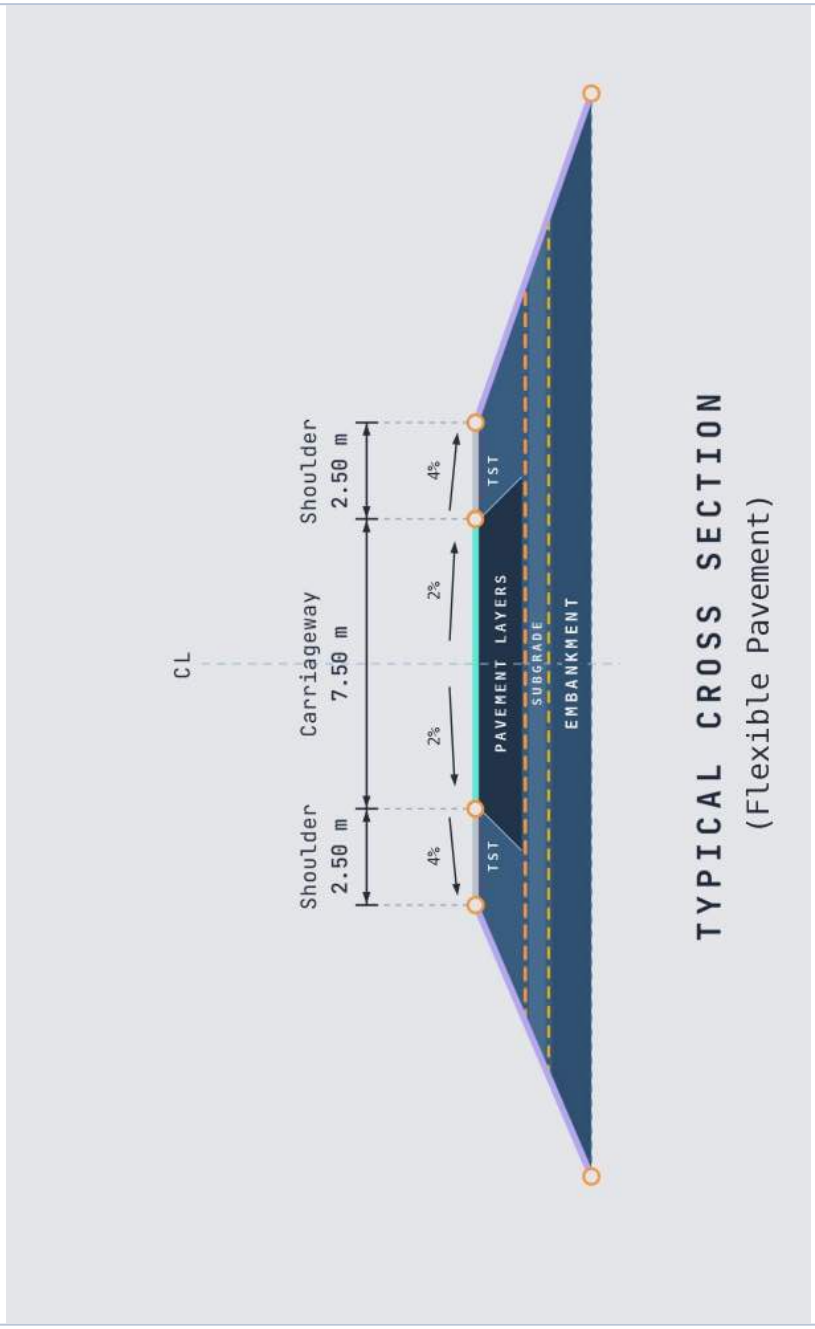
Result

Required SN	4.51
Provided SN, ΣSN	5.75
Status	ADEQUATE margin +1.24

Pavement Layers Sketch



ANNEXURE – C (TYPICAL CROSS SECTIONS)



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

ANNEXURE – D (SOIL INVESTIGATION RESULTS OF CBR)

A design CBR of **20.00%** has been adopted for the subgrade in this design (see Sections 3.4 and 3.5).

Full soil and material investigation report, borehole logs and laboratory CBR test results to be attached separately by the design engineer.

ANNEXURE – E (ASSESSMENT OF ESALS — SUPPORTING DATA)

The Assessment of ESALs is presented in full in the body of this report, immediately following the Executive Summary. The section covers: input data; the truck fleet's axle configuration and individual Load Equivalency Factors (LEFs) from AASHTO 1993 Appendix D (Tables D.1–D.9) by bilinear interpolation on axle load and structural number, and linear interpolation on terminal serviceability index; composite and Adopted equivalency factors; and the Total Daily, Annual, and Design Life ESALs over the 23-year analysis period.

Method	AASHTO Guide for Design of Pavement Structures, 1993 — Appendix D (Tables D.1–D.9)
SN assumed for LEF interpolation	4
P_t assumed for LEF interpolation	2.5
Total analysis period	23 years
Traffic growth rate	3%
Growth Factor (GF)	26.87
Total Daily ESAL	2,365
Total Annual ESAL	863,161
Cumulative ESALs (Design W_{18} — raw)	25,344,123
Design ESAL, W_{18}	**25.34 million**
$\log_{10}(W_{18})$	7.4039