



Project Name: REBUS STUDIO SHPK

Design #:

Date:

4 | SUBGRADE

Evaluation of Annual-equivalent Subgrade Strength according to Seasonal Relative Damage.

Subgrade Description:

Modulus-CBR Correlation $M_R = 17.6 (\text{CBR})^{0.64}$

Table 1 - Seasonal Subgrade Strength

Subgrade Strength	CBR	M_R	Duration	Relative Damage
	[%]	[MPa]	[months]	
Minimum:	4.0	42.7	6.0	0.1878
Maximum:	8.0	66.6	6.0	0.0671

Where:

Relative Damage for Minimum Subgrade Strength: $u_f^{\min} = 1.18 \times 10^8 (M_{R(\text{psi})}^{\min})^{-2.32}$

Relative Damage for Maximum Subgrade Strength: $u_f^{\max} = 1.18 \times 10^8 (M_{R(\text{psi})}^{\max})^{-2.32}$

Average Relative Damage: $u_{\text{avg}} = 0.1275$

Annual-equivalent Subgrade Resilient Modulus: $M_R = \left[\frac{u_f^{\text{avg}}}{(1.18 \times 10^8)} \right]^{-1/2.32} = 50.5 \text{ MPa}$

Annual-equivalent Subgrade CBR: $\text{CBR} = 5.2 \%$



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5 | TRAFFIC

The number of 18-kip (W_{18}) Equivalent Single Axle Loads (ESAL's) applications is used to define the number of the equivalent traffics based on standard truck axle loads (AASHTO 1993).

Road Design Life: 15.0 [years]

Tire Pressure: 550 [kPa]

Input W_{18} : 41,169



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6 | UNREINFORCED PAVEMENT

6.1 Pavement Configuration

Table 6.1- Unreinforced Pavement Configuration

Layer		Poisson's Ratio	Modulus [MPa]	Thickness [mm]	Cost [\$/m ²]
No.	Description				
1	Asphalt Concere	0.40	3,000.0	30	
2	Asphalt Concere Binder	0.40	2,800.0	50	
3	High-quality Granular Base	0.35	550.0	150	
4	Crushed Stone	0.30	155.0	400	
5	Subgrade:	0.45	50.5	Semi-inf.	-

6.2 Equivalent HMA Modulus

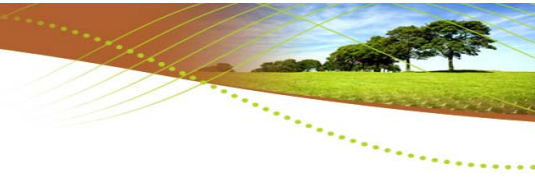
No. of Asphalt Layers: 2

$$E_{ACeq}^{(un)} = 2,874 \text{ MPa}$$

6.3 Fatigue Failure Criteria

Examination of the Fatigue Failure Criteria according to the horizontal tensile strain at the bottom of the Asphalt layer (ϵ_t) and the elastic modulus of the Asphalt. One commonly accepted criterion developed by Finn et al. (1977) is:

$$\log W_{18}^{Fatigue} = 15.947 - 3.29 \log (\epsilon_t/10^{-6}) - 0.854 \log (E_{AC}/10^3)$$



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Where:

E_{AC} = elastic modulus of the Asphalt [psi]

ϵ_t = horizontal tensile strain at the bottom of the Asphalt layer

Input Strain according to Layered Elastic Model: $\epsilon_t = 2.670E-04$

$W_{18}^{Fatigue}$ = number of W_{18} cycles to Fatigue Failure (10% cracking of wheelpath area)

$W_{18}^{Fatigue} = 530,000$

6.4 Rutting Failure Criteria

Examination of the Rutting Failure Criteria according to the vertical compressive strain (ϵ_v) at the top of the subgrade layer:

$$W_{18}^{Rutting} = 1.077 \times 10^{18} (10^{-6} / \epsilon_c)^{4.4843}$$

Where:

ϵ_c = vertical compressive strain at the top of the subgrade layer

Input Strain according to Layered Elastic Model: $\epsilon_c = 2.720E-04$

$W_{18}^{Rutting}$ = number of W_{18} cycles to 12.5mm Rutting Failure

$W_{18}^{Rutting} = 13,030,000$

6.5 Deflection Failure Criteria

Examination of the Surface Deflection Failure Criteria according to AASHO Road Test (Highway Research Board, 1962b):

$$\log W_{18}^{Deflection} = 11.06 - 3.25 \log (D_0 \times 10^3)$$

Where:

D_0 = Surface Deflection [in.]

Input Deflection according to Layered Elastic Model: $D_0 = 1.614E-02 \text{ in.} = 4.100E-01 \text{ mm}$

$W_{18}^{Deflection}$ = number of W_{18} cycles to Deflection Failure (2.5 terminal serviceability)

$W_{18}^{Deflection} = 13,620,000$



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6.6 Unreinforced Pavement Performance

Design Pavement Performance according to minimum W_{18} Failure Criteria:

$$W_{18}^{UN} = \text{Min} (W_{18}^{\text{Fatigue}}, W_{18}^{\text{Rutting}}, W_{18}^{\text{Deflection}}) = 530,000$$

6.7 Unreinforced Design Examination

Design W_{18}		Predicted W_{18}	
(design performance)		(required)	
530,000	\geq	41,169	OK!