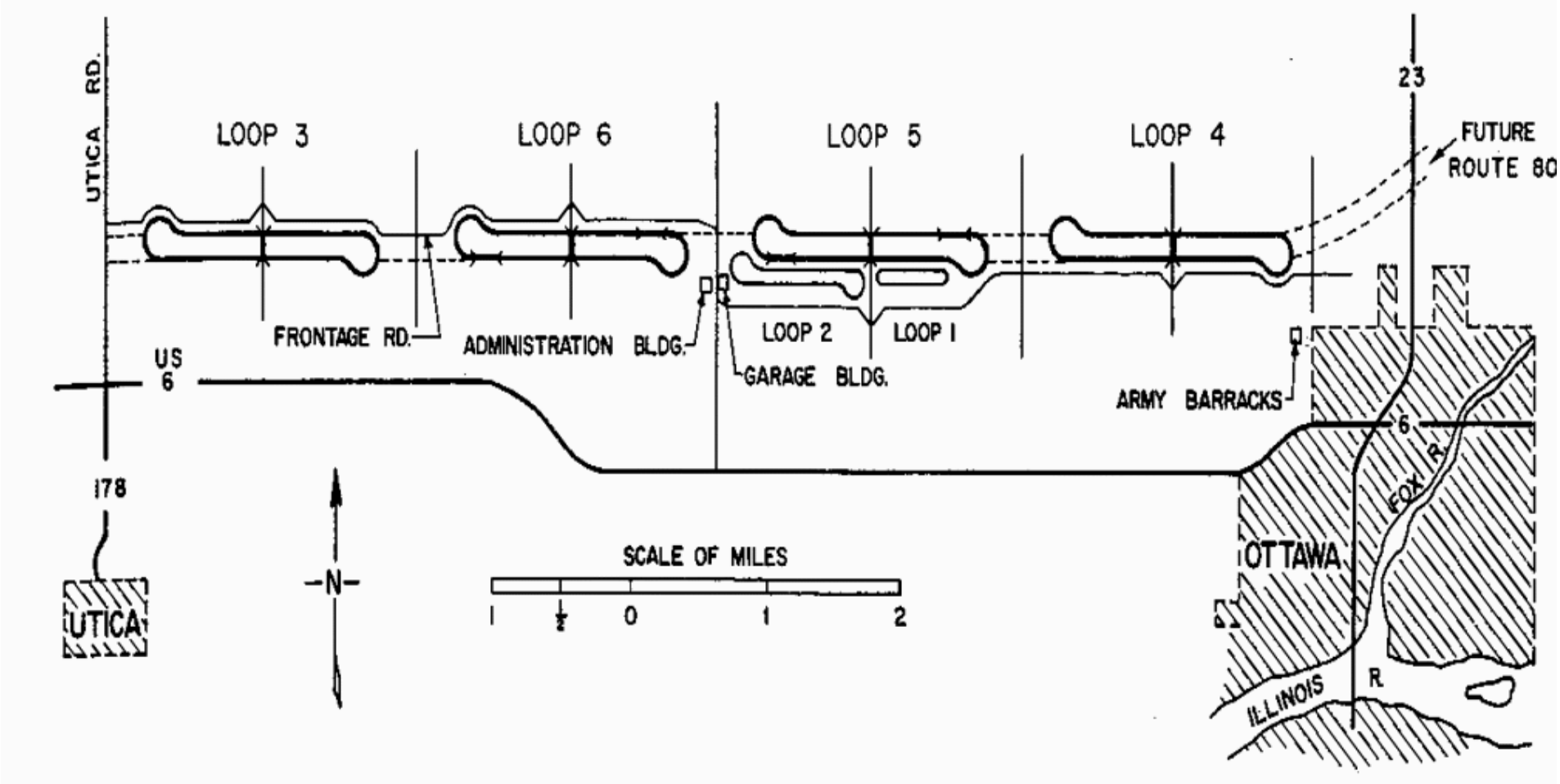
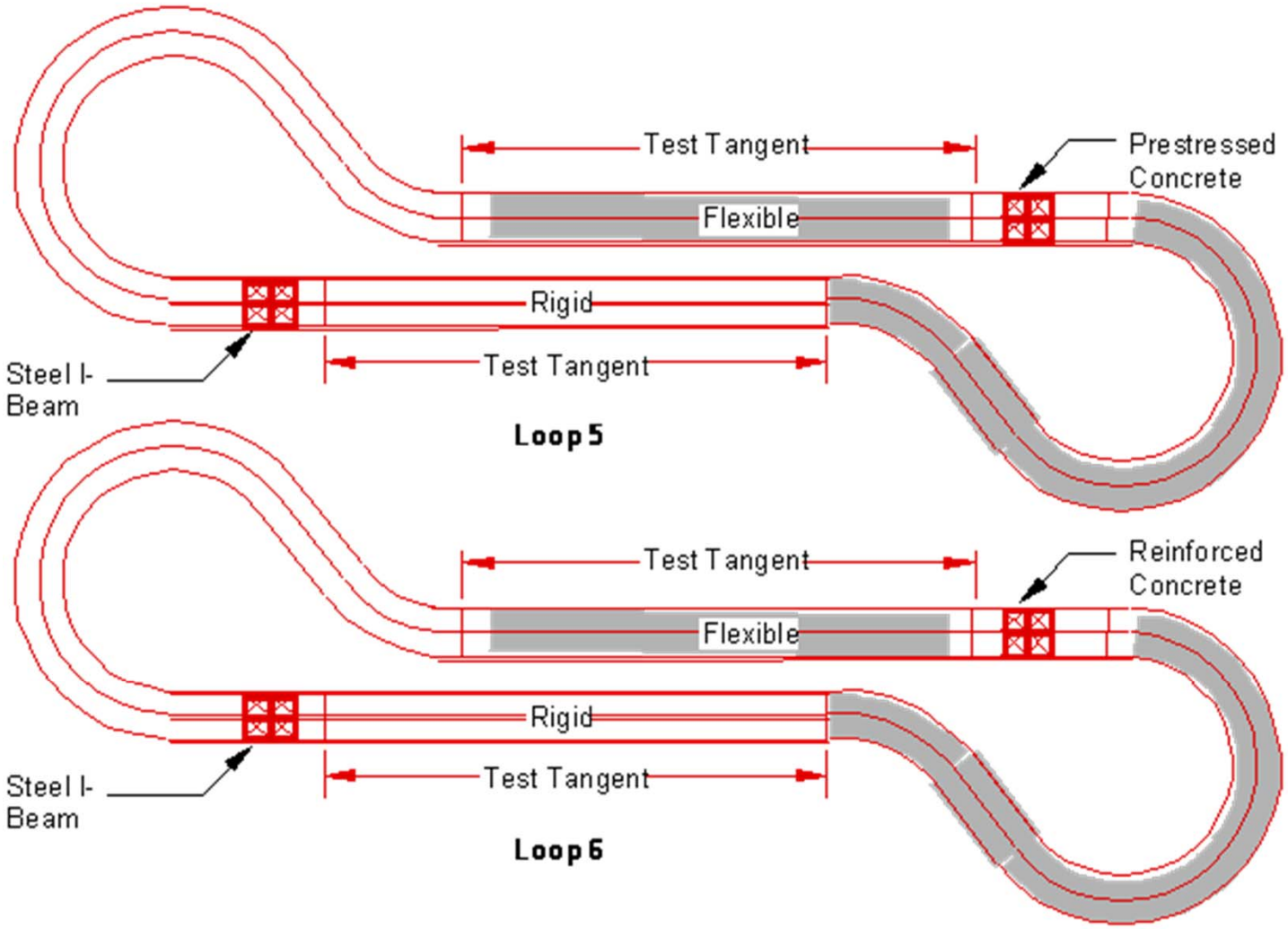
Pavement Performance

AASHO Road Test



Source: Highway Research Board Special Report 73

AASHO Road Test



Source: WSDOT Pavement Guide Interactive CD-ROM

AASHO Road Test

Source: http://www.fhwa.dot.gov

AASHO Road Test

Table 5: AASHO Road Test Structural Design Thickness Summary

Loop No.	AC Thickness (in.)	Base Thickness (in.)	Subbase Thickness (in.)
1	1.0	0.0	0.0
	3.0	6.0	8.0
	5.0	--	16.0
2	1.0	0.0	0.0
	2.0	3.0	4.0
	3.0	6.0	8.0
3	2.0	0.0	0.0
	3.0	3.0	4.0
	4.0	6.0	--
4	3.0	0.0	4.0
	4.0	3.0	8.0
	5.0	6.0	12.0
5	3.0	3.0	4.0
	4.0	6.0	8.0
	5.0	9.0	12.0
6	4.0	3.0	8.0
	5.0	6.0	12.0
	6.0	9.0	16.0

Source: WSDOT Pavement Guide Interactive CD-ROM

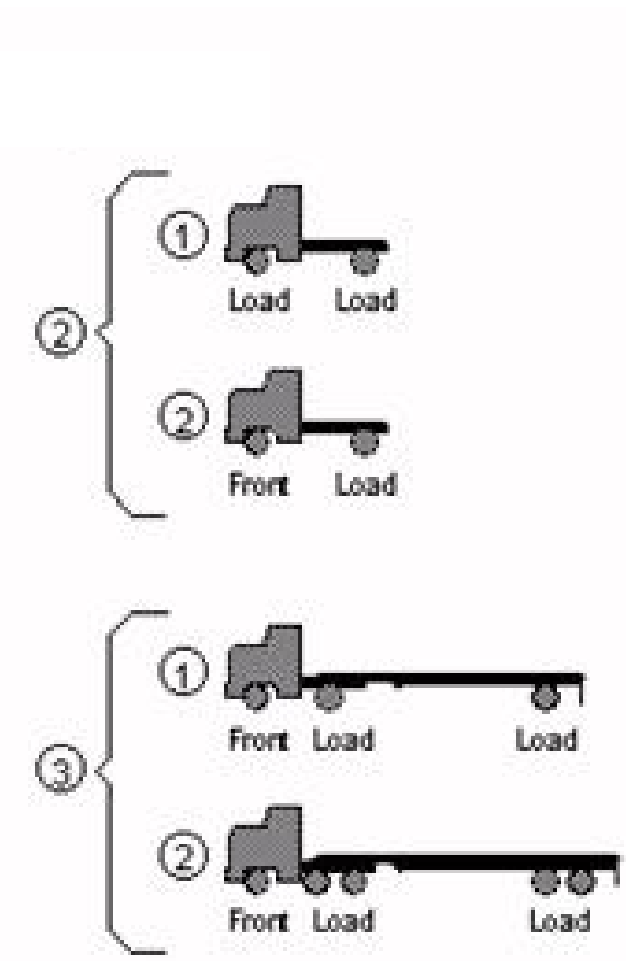
AASHO Road Test

Table 13: Rigid Pavement Structural Design Parameters

Loop No.	PCC Slab Thickness (in.)	Subbase Thickness (in.)	Transverse Dowel Bars (Diameter x Length)
1	2.5 5.0 9.5 12.5	0, 6.0 0, 6.0 0, 6.0 0, 6.0	3/8" x 12" 5/8" x 12" 1 1/4" x 18" 1 5/8" x 18"
2	2.5 3.5 5.0	0, 3.0, 6.0 0, 3.0, 6.0 0, 3.0, 6.0	3/8" x 12" 1/2" x 12" 5/8" x 12"
3	3.5 5.0 6.5 8.0	3.0, 6.0, 9.0 3.0, 6.0, 9.0 3.0, 6.0, 9.0 3.0, 6.0, 9.0	1/2" x 12" 5/8" x 12" 7/8" x 18" 1" x 18"
4	5.0 6.5 8.0 9.5	3.0, 6.0, 9.0 3.0, 6.0, 9.0 3.0, 6.0, 9.0 3.0, 6.0, 9.0	5/8" x 12" 7/8" x 18" 1" x 18" 1 1/4" x 18"
5	6.5 8.0 9.5 11.0	3.0, 6.0, 9.0 3.0, 6.0, 9.0 3.0, 6.0, 9.0 3.0, 6.0, 9.0	7/8" x 18" 1" x 18" 1 1/4" x 18" 1 3/8" x 18"
6	8.0 9.5 11.0 12.5	3.0, 6.0, 9.0 3.0, 6.0, 9.0 3.0, 6.0, 9.0 3.0, 6.0, 9.0	1" x 18" 1 1/4" x 18" 1 3/8" x 18" 1 5/8" x 18"

Source: WSDOT Pavement Guide Interactive CD-ROM

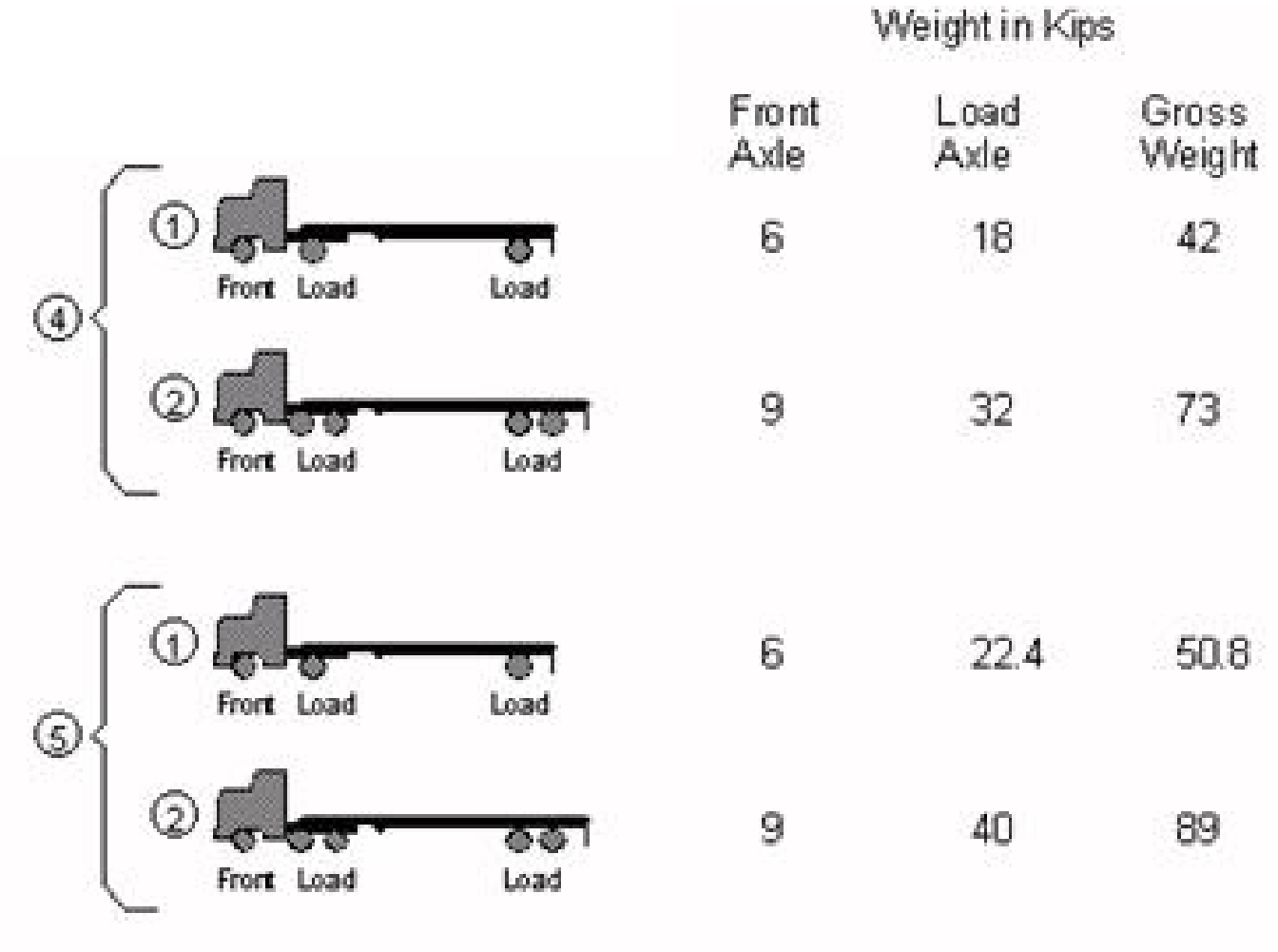
AASHO Road Test



	Weight in Kips		
	Front Axle	Load Axle	Gross Weight
① Load Load	2	2	4
② Front Load	2	6	8
① Front Load Load	4	12	28
② Front Load Load	6	24	54

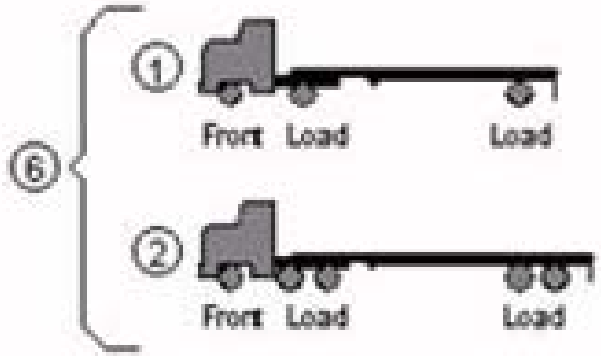
Source: WSDOT Pavement Guide Interactive CD-ROM

AASHO Road Test



Source: WSDOT Pavement Guide Interactive CD-ROM

AASHO Road Test



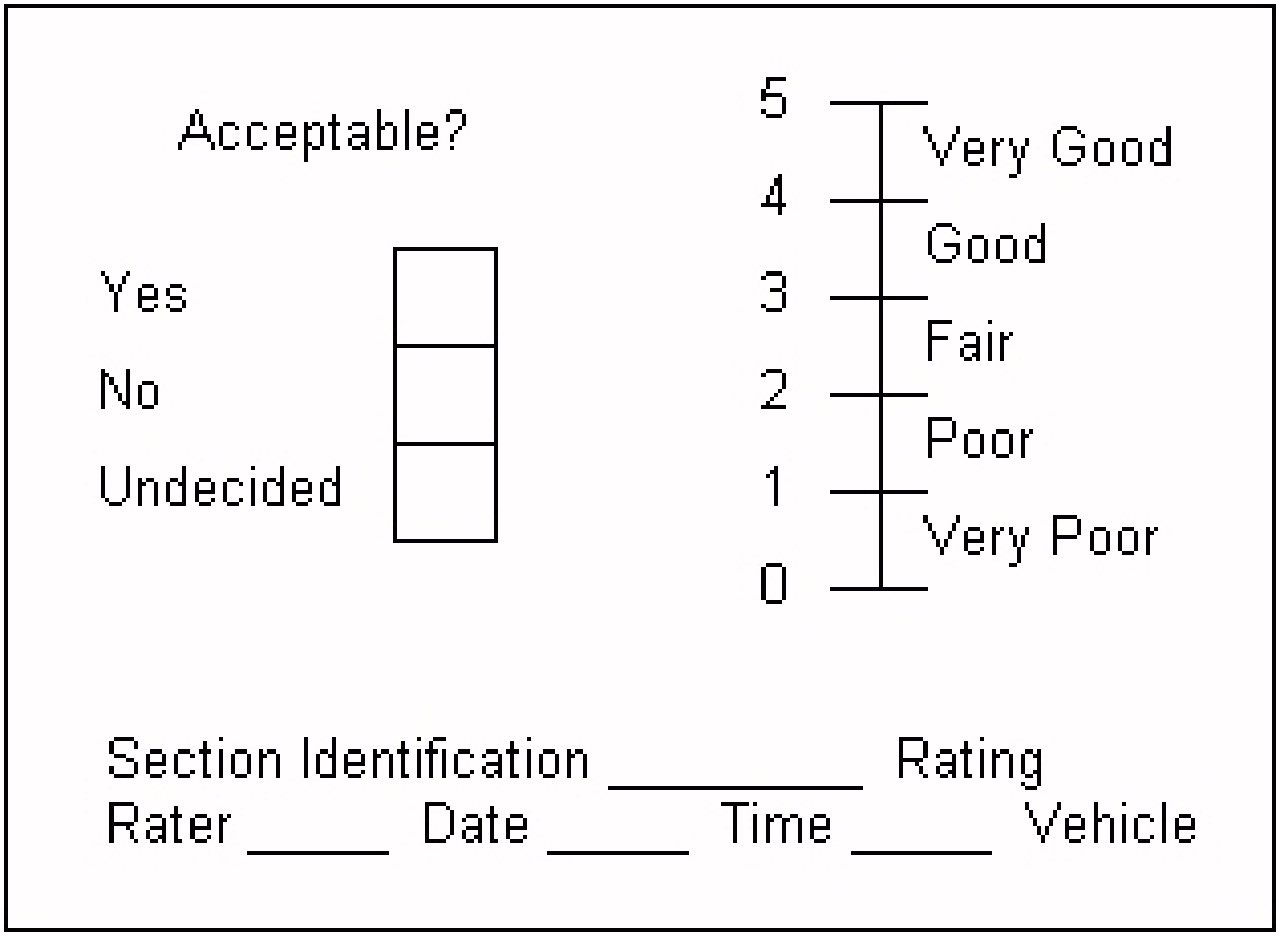
	Weight in Kips		
	Front Axle	Load Axle	Gross Weight
①	9	30	69
②	12	48	108

Source: WSDOT Pavement Guide Interactive CD-ROM

Present Serviceability Rating

"The judgment of an observer as to the current ability of a pavement to serve the traffic it is meant to serve"

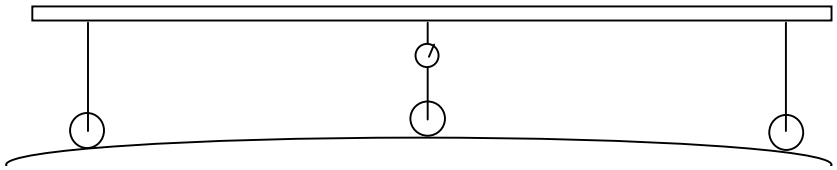
Present Serviceability Rating



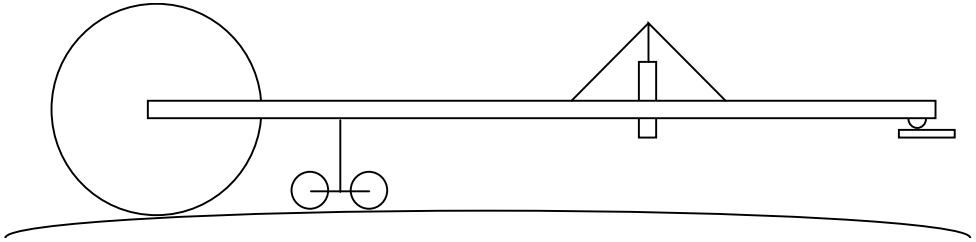
Acceptable Ride Quality

PSR	Acceptable?
3.0	88%
2.5	45%
2.0	15%

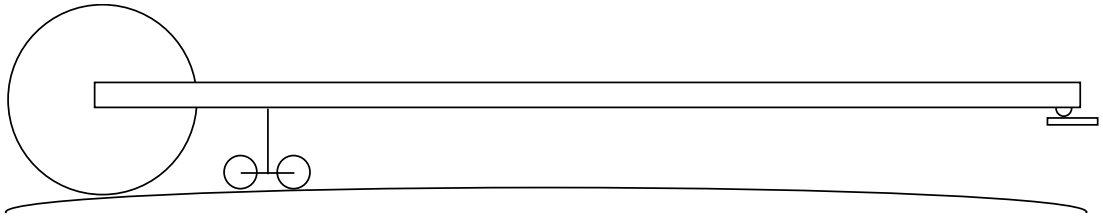
Measuring Roughness



Straightedge

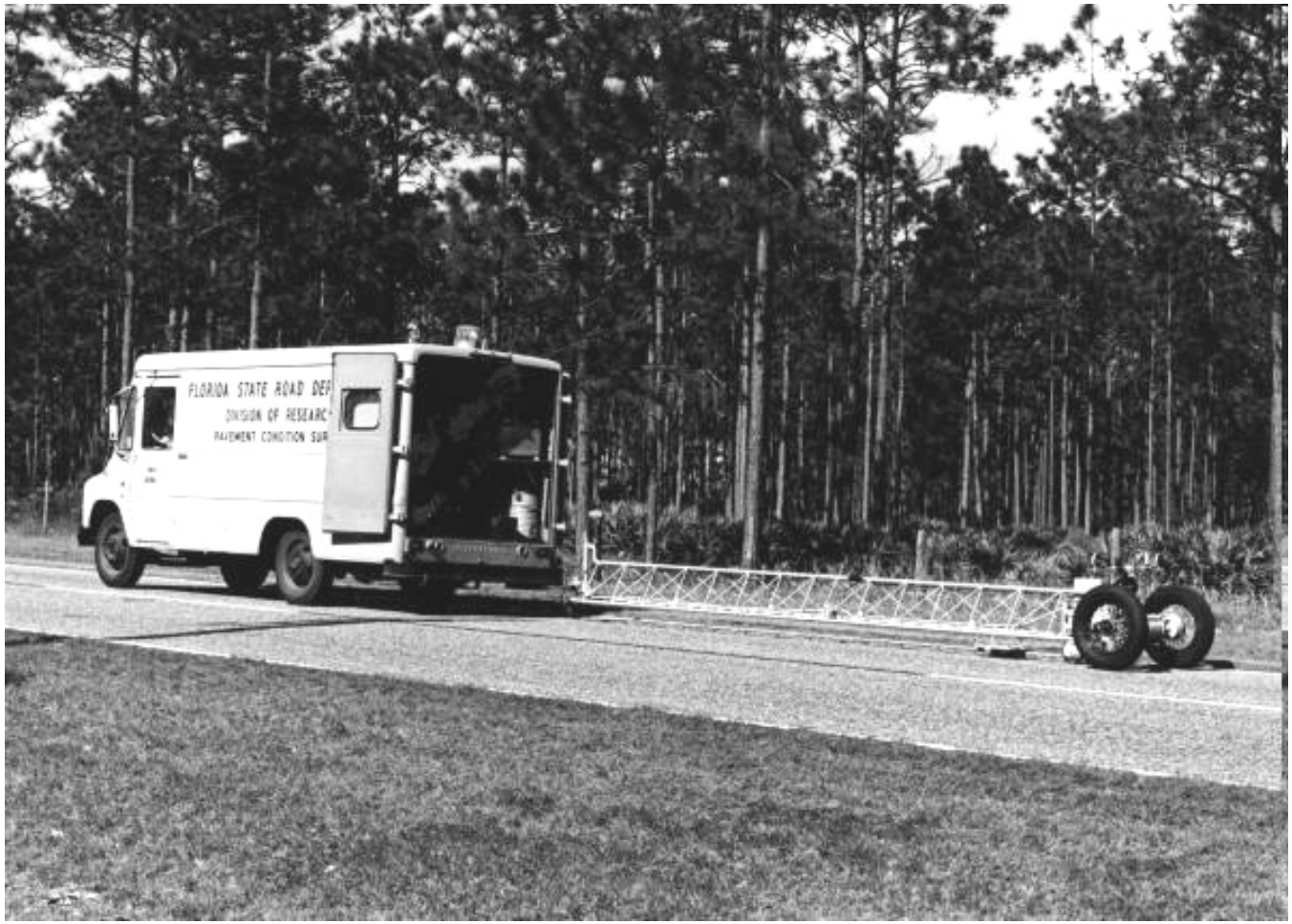


Slope Profilometer



CHLOE Profilometer

CHLOE Profilometer



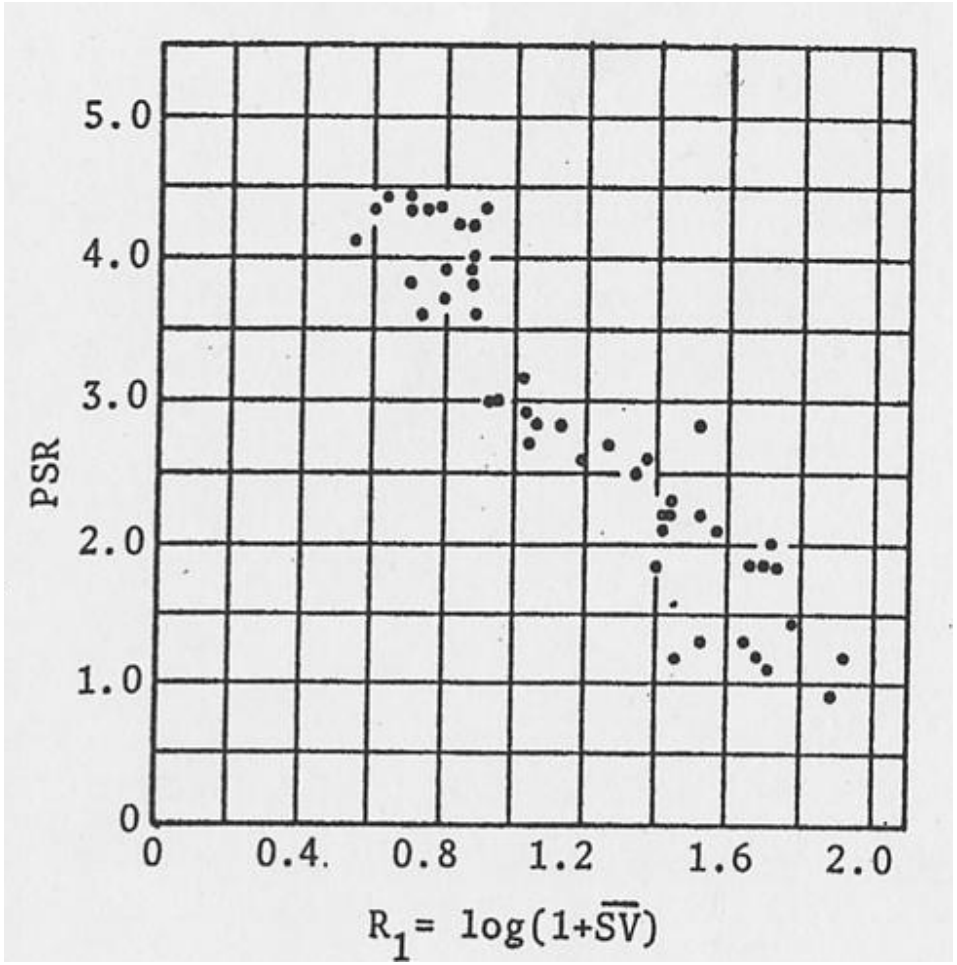
Source: State Library and Archives of Florida

Slope Variance

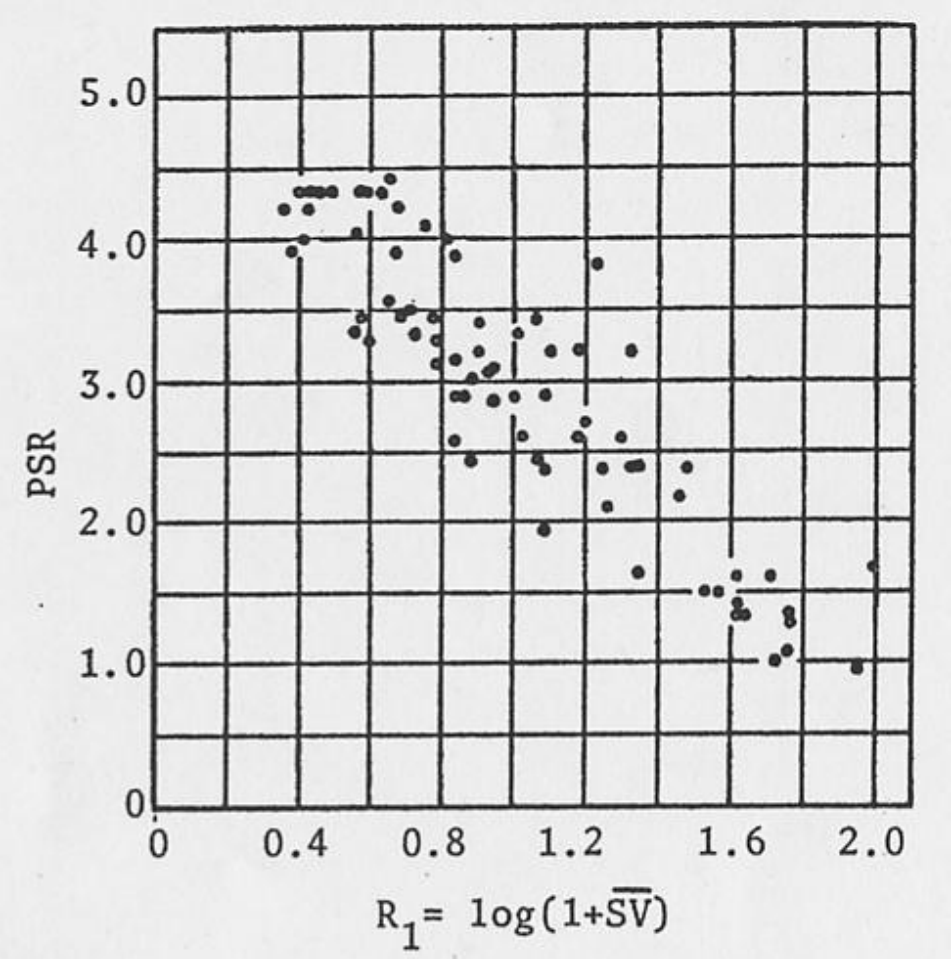
$$SV = \frac{\sum S^2 - \frac{1}{n}\left(\sum S\right)^2}{n-1} \times 10^6$$

S = slope (radians)

Flexible Pavements



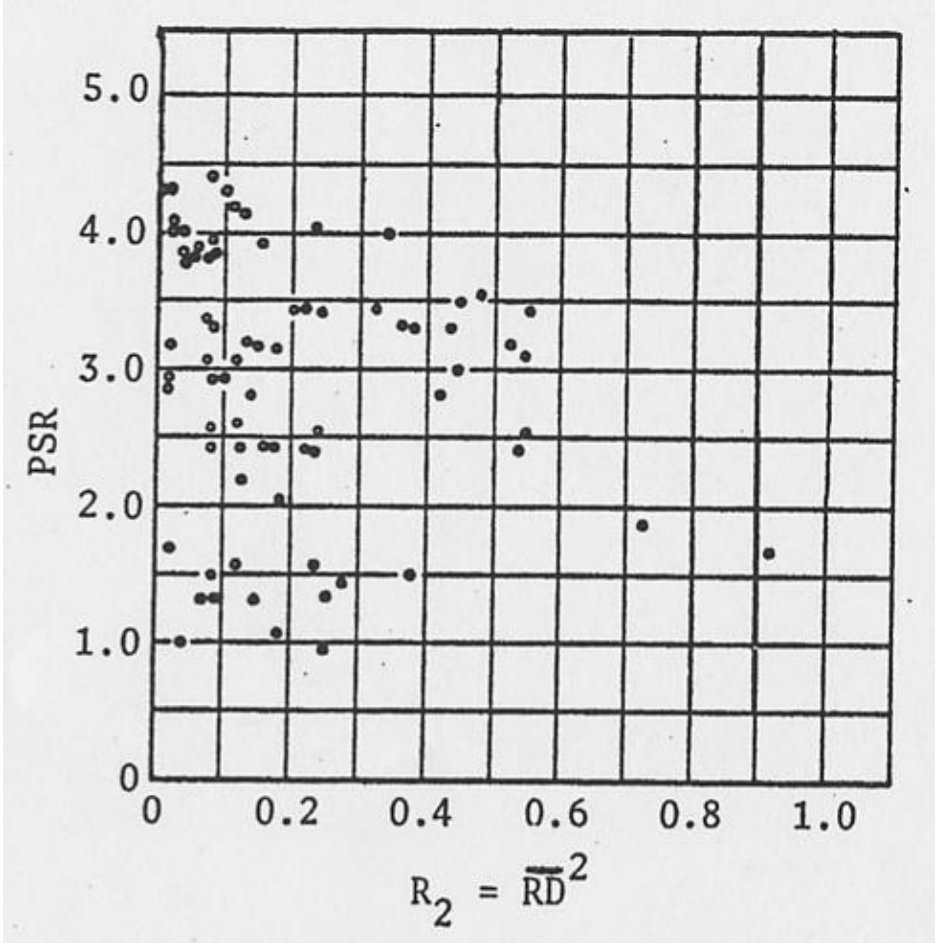
Rigid Pavements



Rut Depth

Source: www.halifax.ca/Works/AsphaltDefectGuide.html

Flexible Pavements



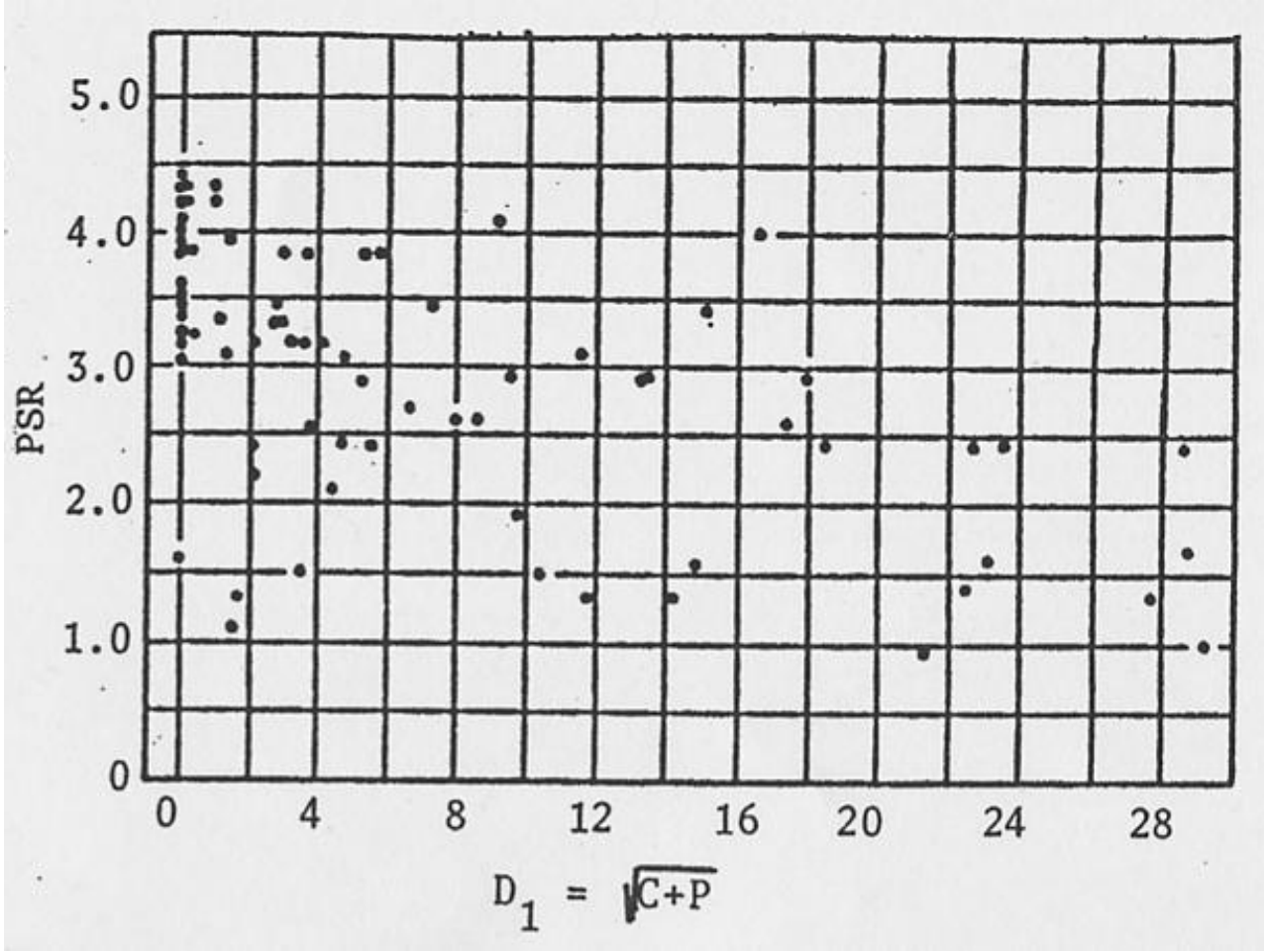
Cracking

Source: www.asphaltrescue.com

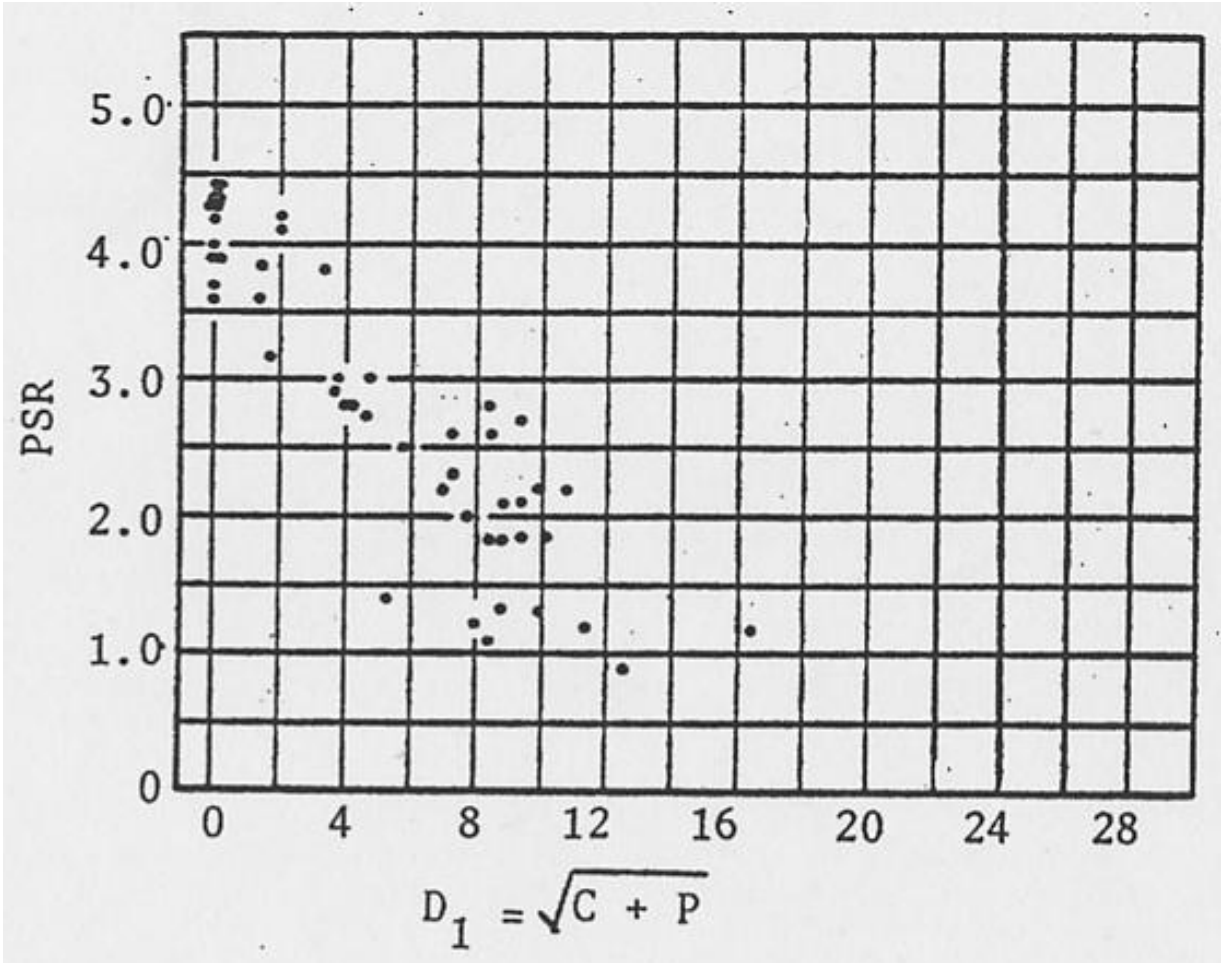
Patching

Source: www.asphaltrescue.com

Flexible Pavements



Rigid Pavements



Present Serviceability Index

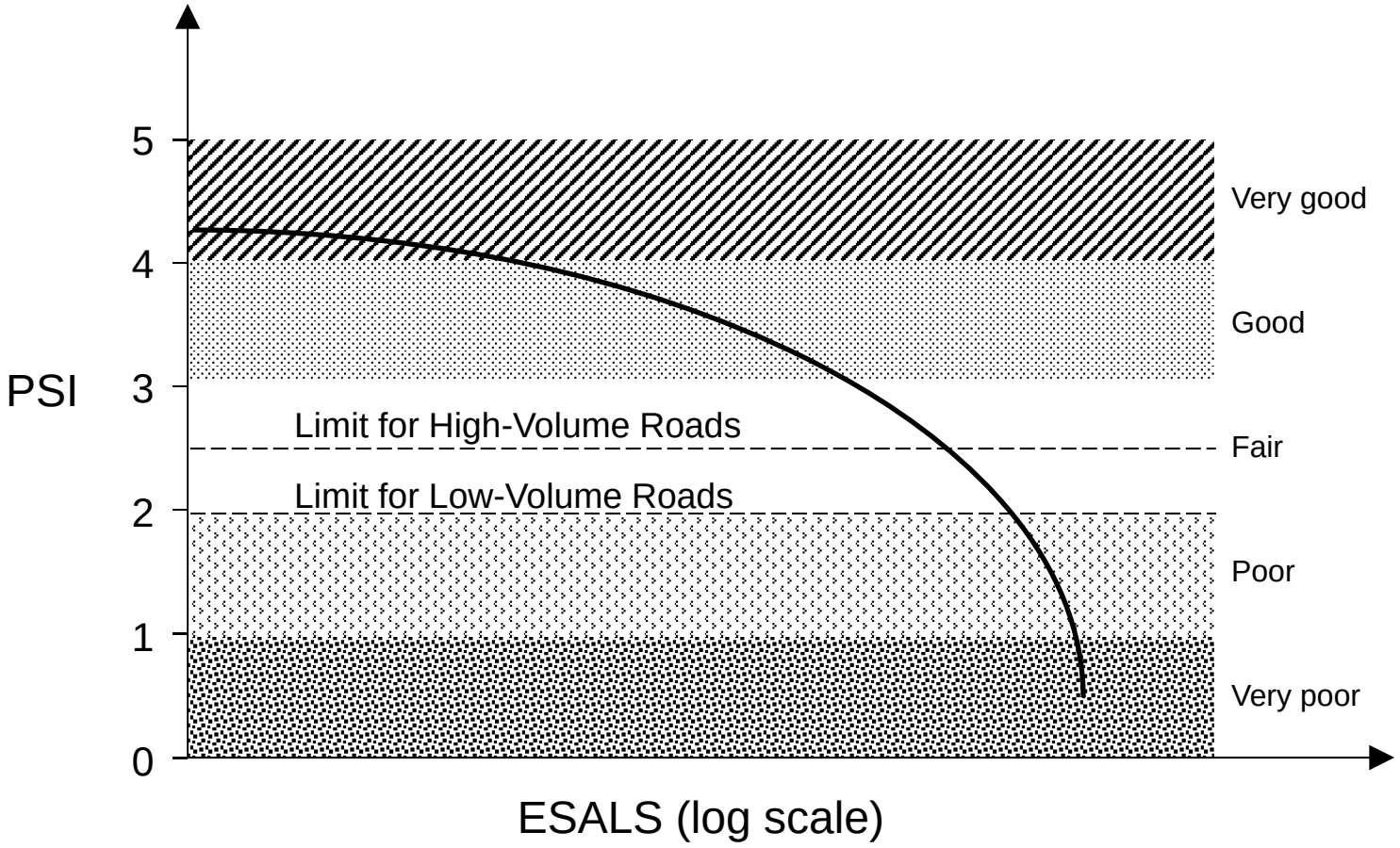
Flexible Pavements

$$PSI = 5.03 - 1.9\log(1+SV) - 1.38RD^2 - 0.01\sqrt{C+P}$$

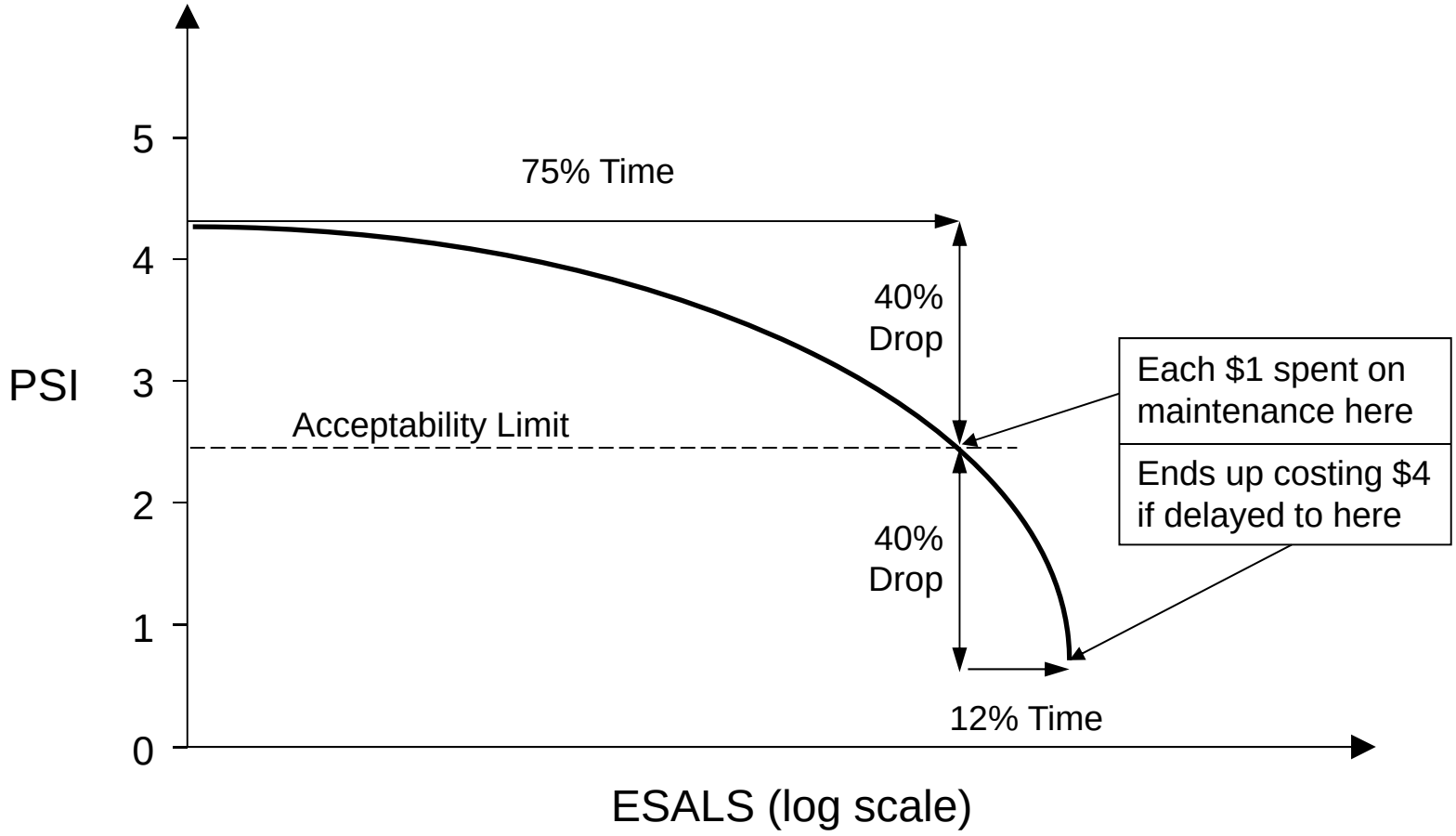
Rigid Pavements

$$PSI = 5.41 - 1.8\log(1+SV) - 0.09\sqrt{C+P}$$

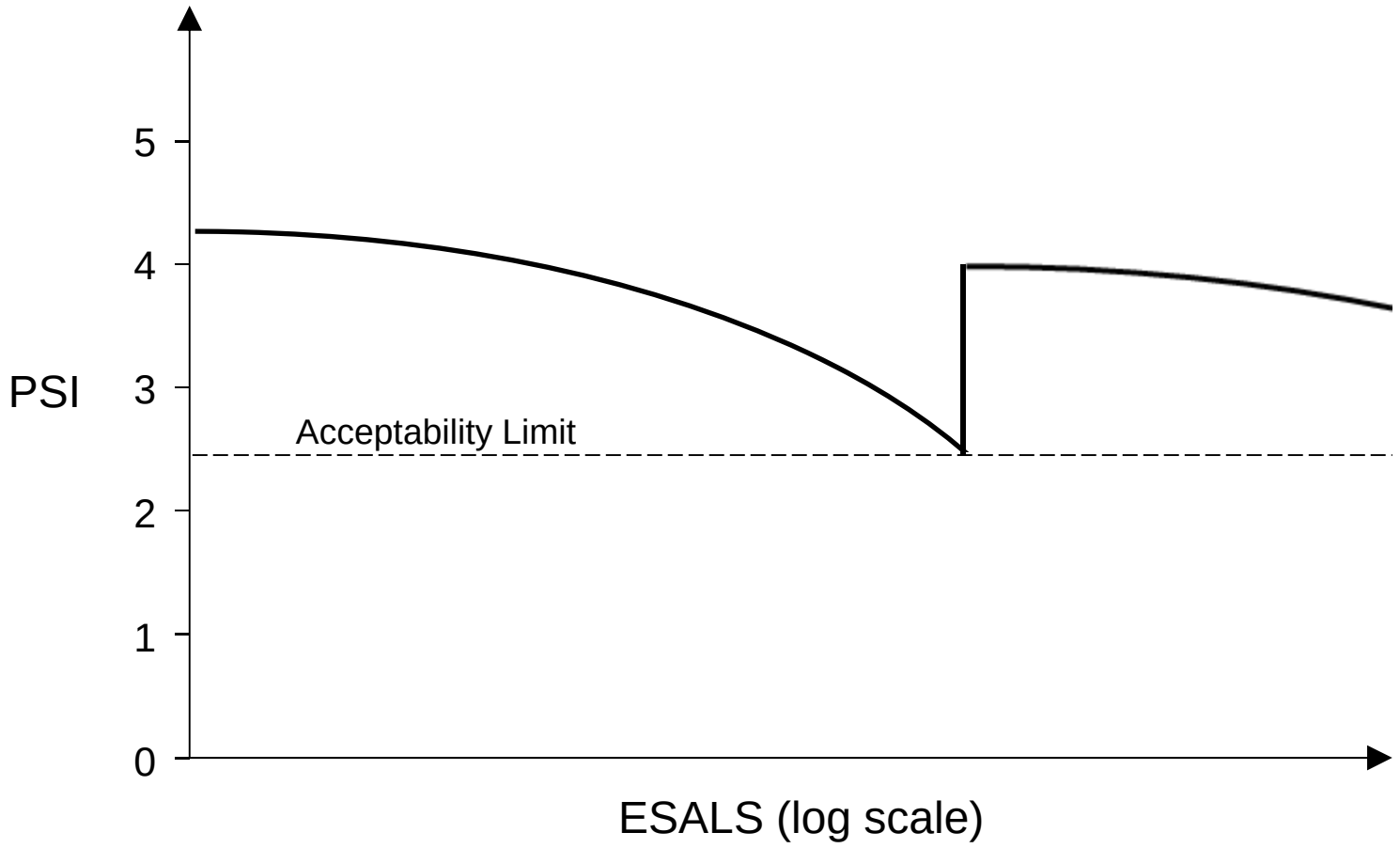
Pavement Performance



Pavement Performance



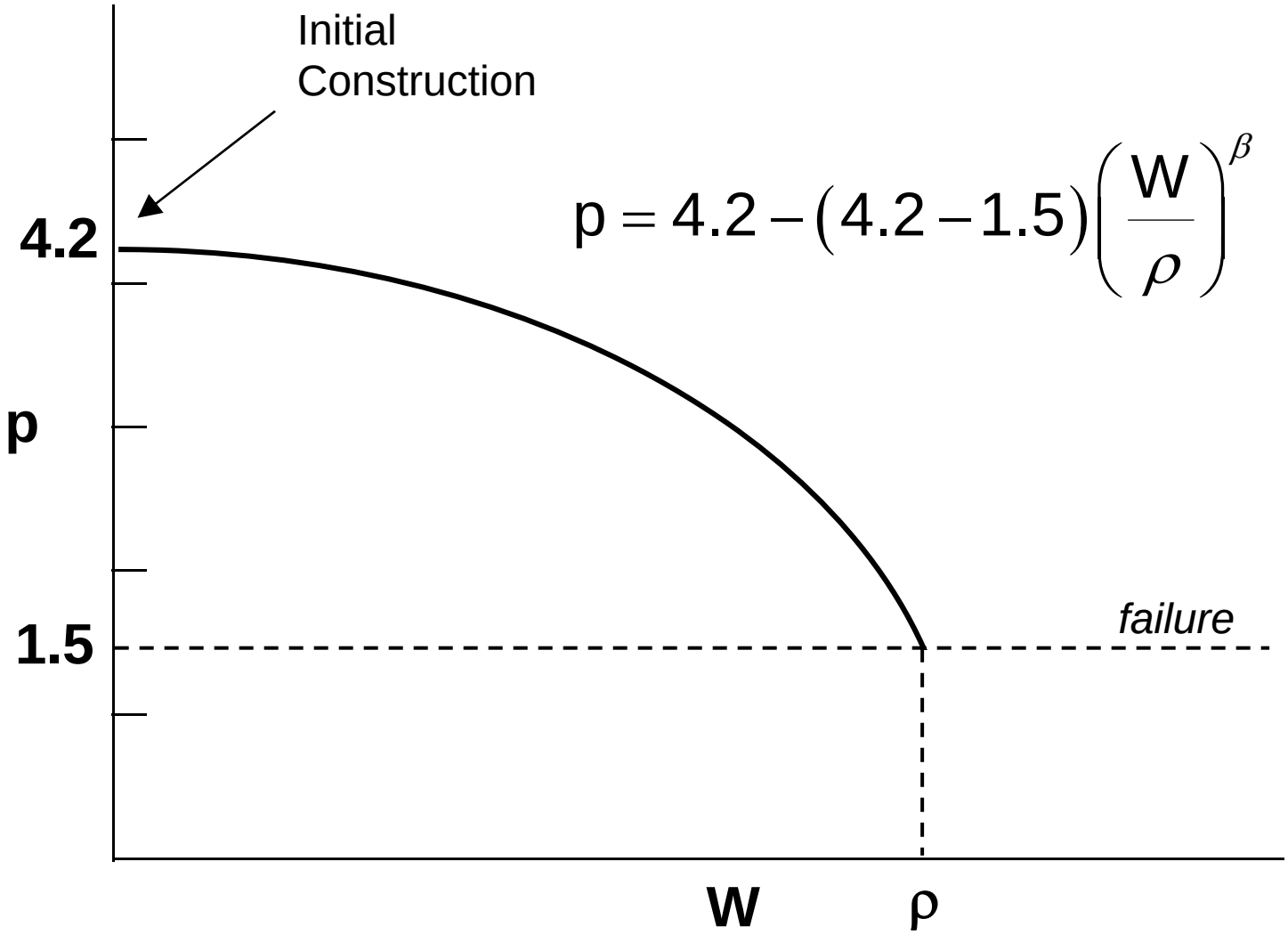
Pavement Performance



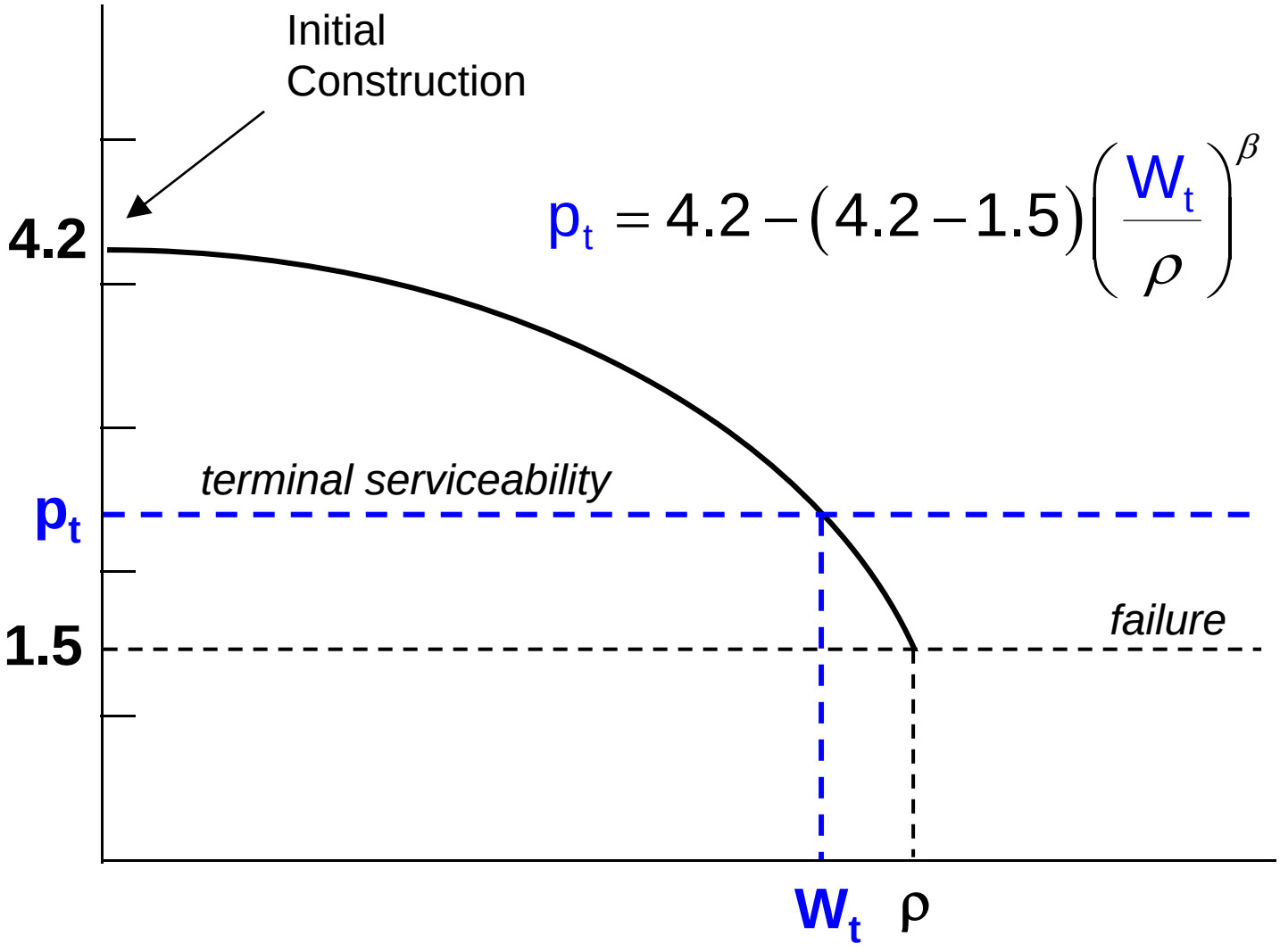
AASHTO Design Equation

(Flexible Pavements)

Pavement Performance



Pavement Performance

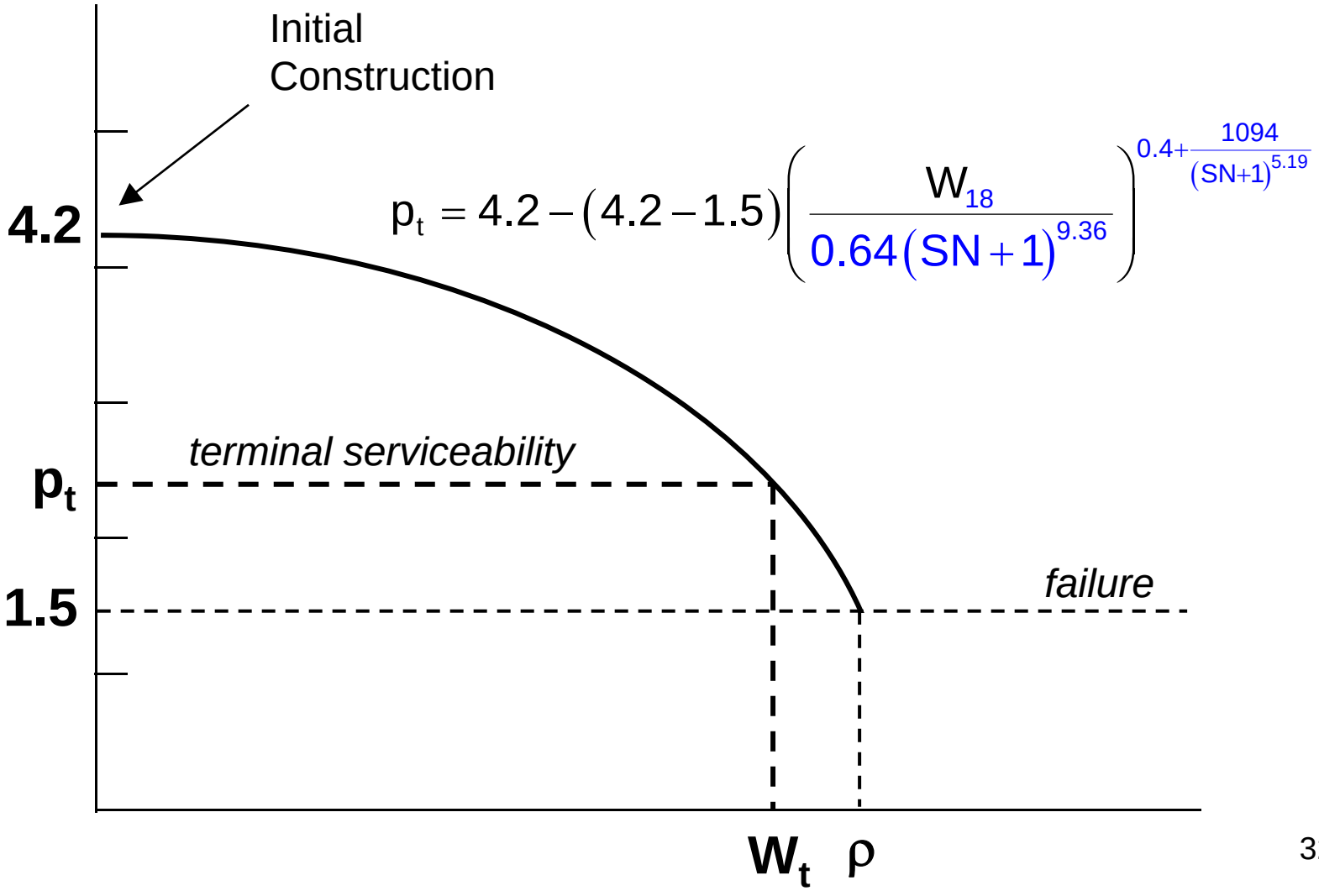


Flexible Performance

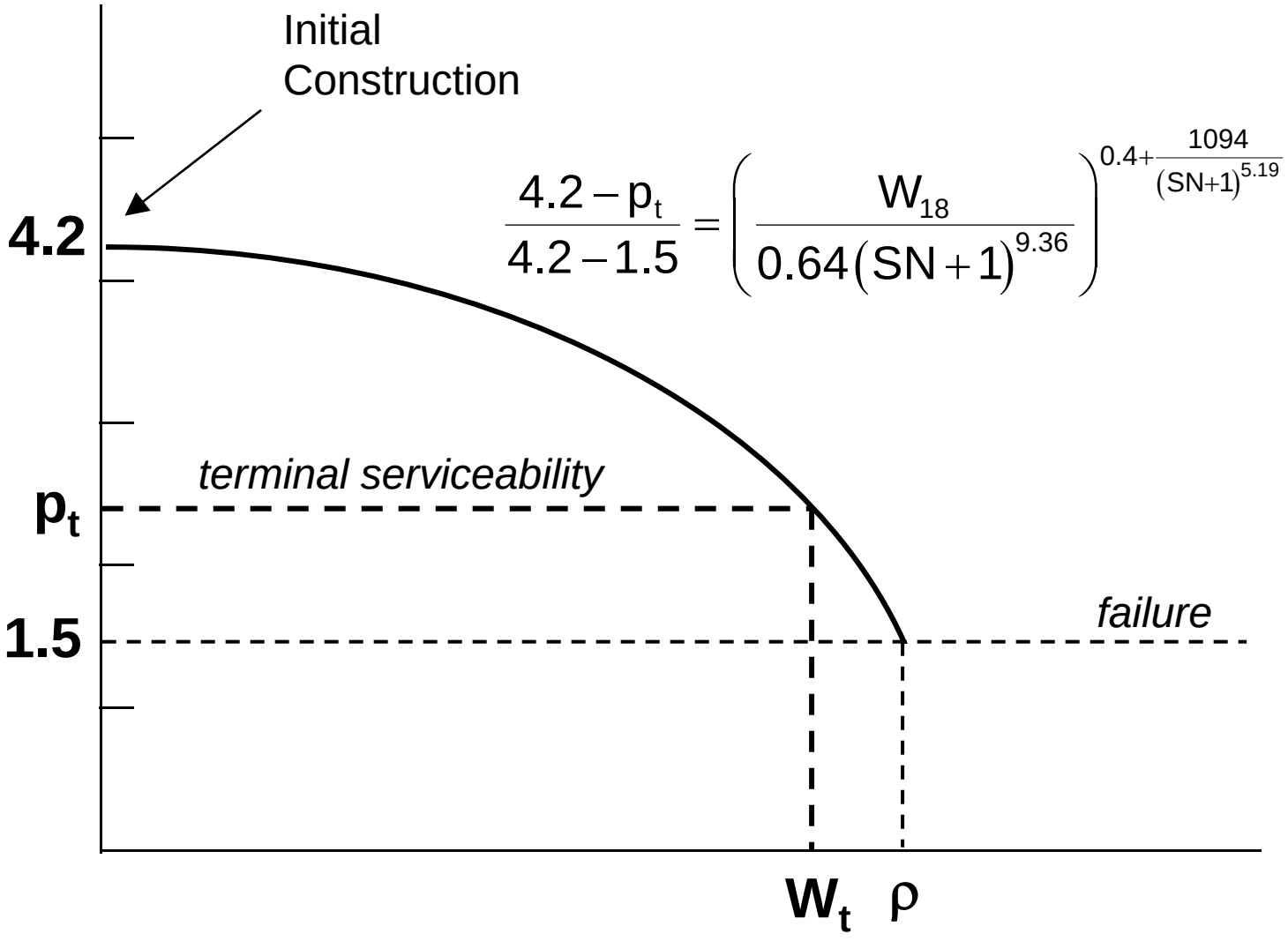
$$\beta_{18} = 0.4 + \frac{0.081(18+1)^{3.23}}{(SN+1)^{5.19}1^{3.23}} = 0.4 + \frac{1094}{(SN+1)^{5.19}}$$

$$\rho_{18} = \frac{10^{5.93}(SN+1)^{9.36}1^{4.33}}{(18+1)^{4.79}} = 0.64(SN+1)^{9.36}$$

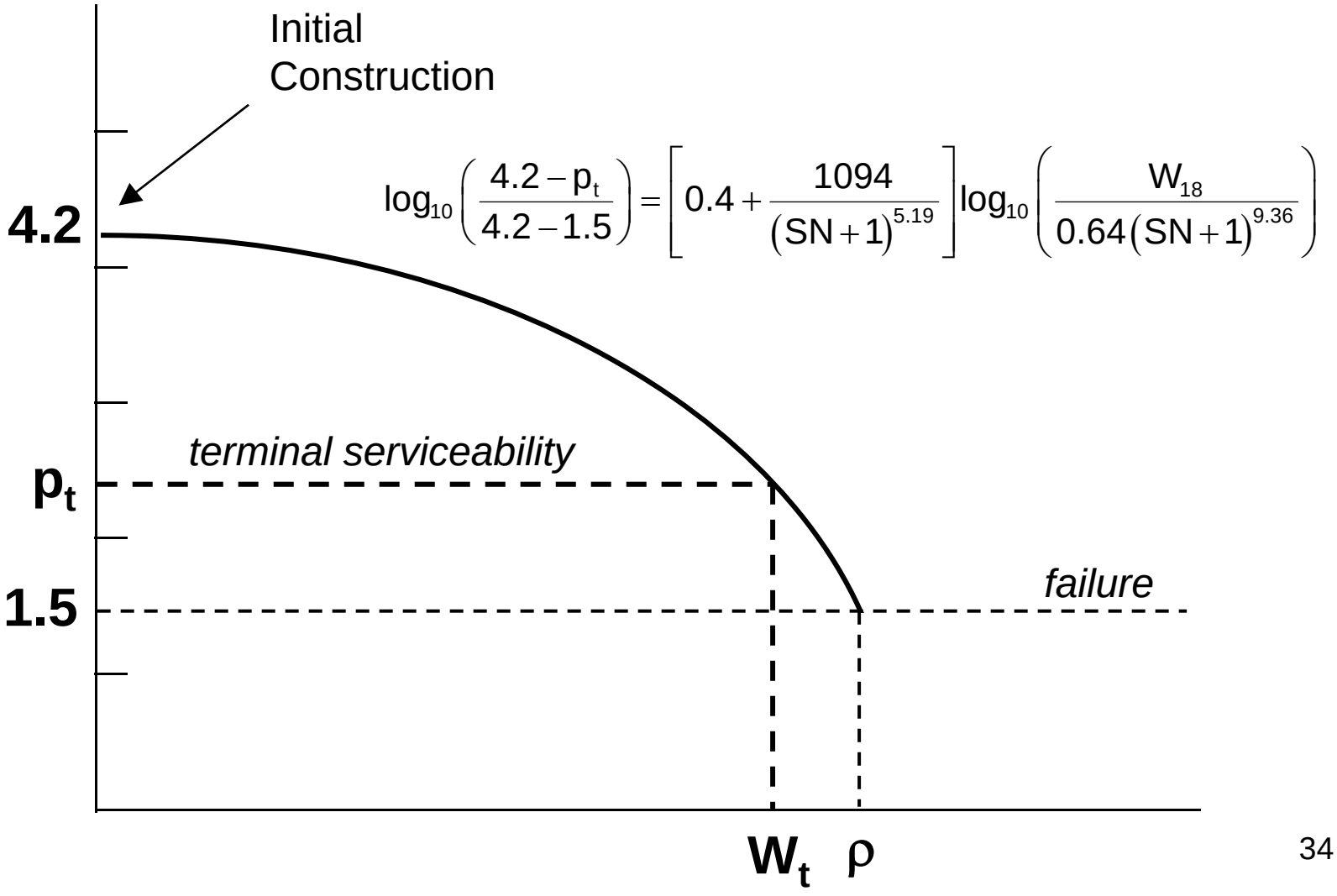
Pavement Performance



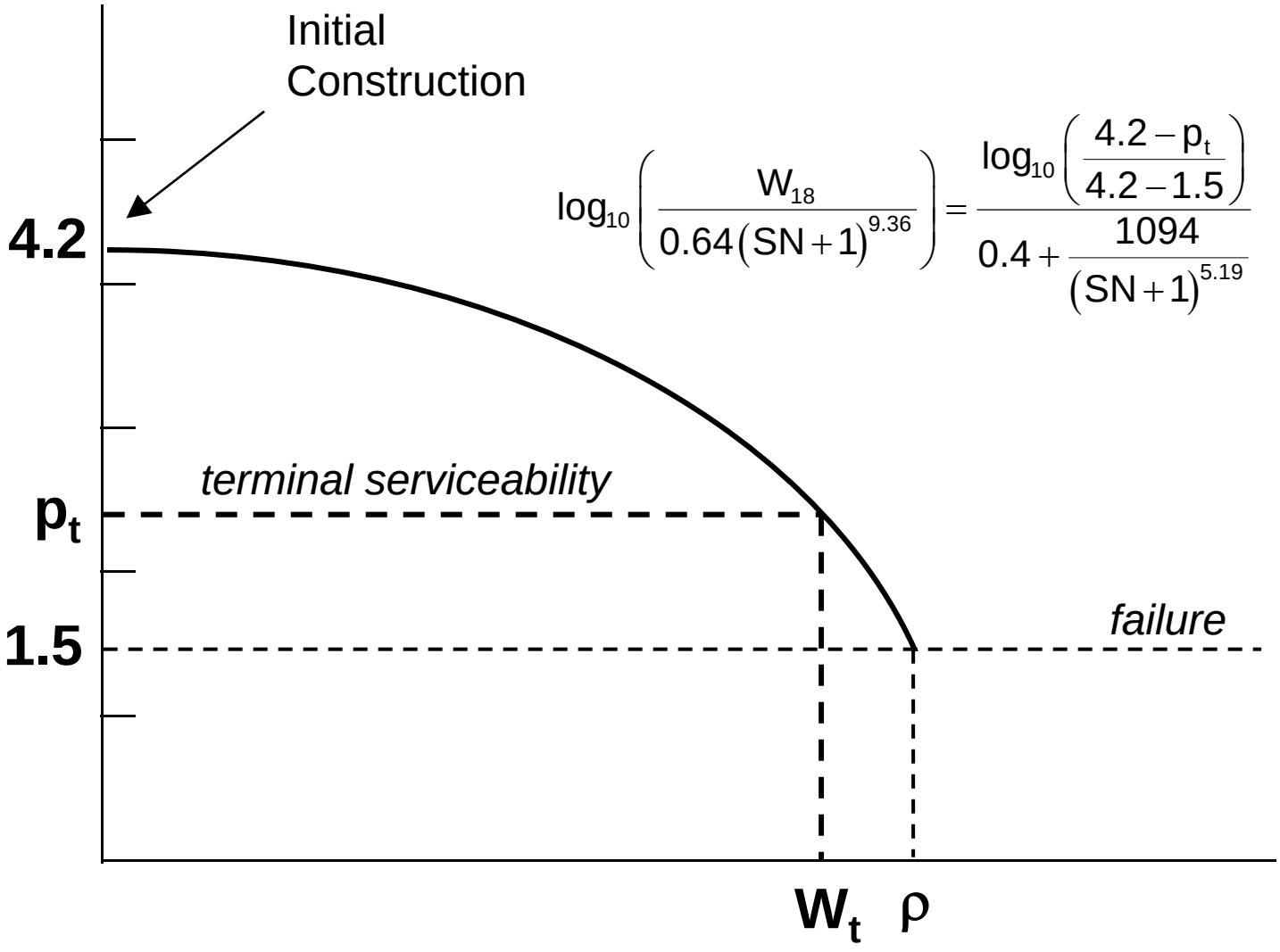
Pavement Performance



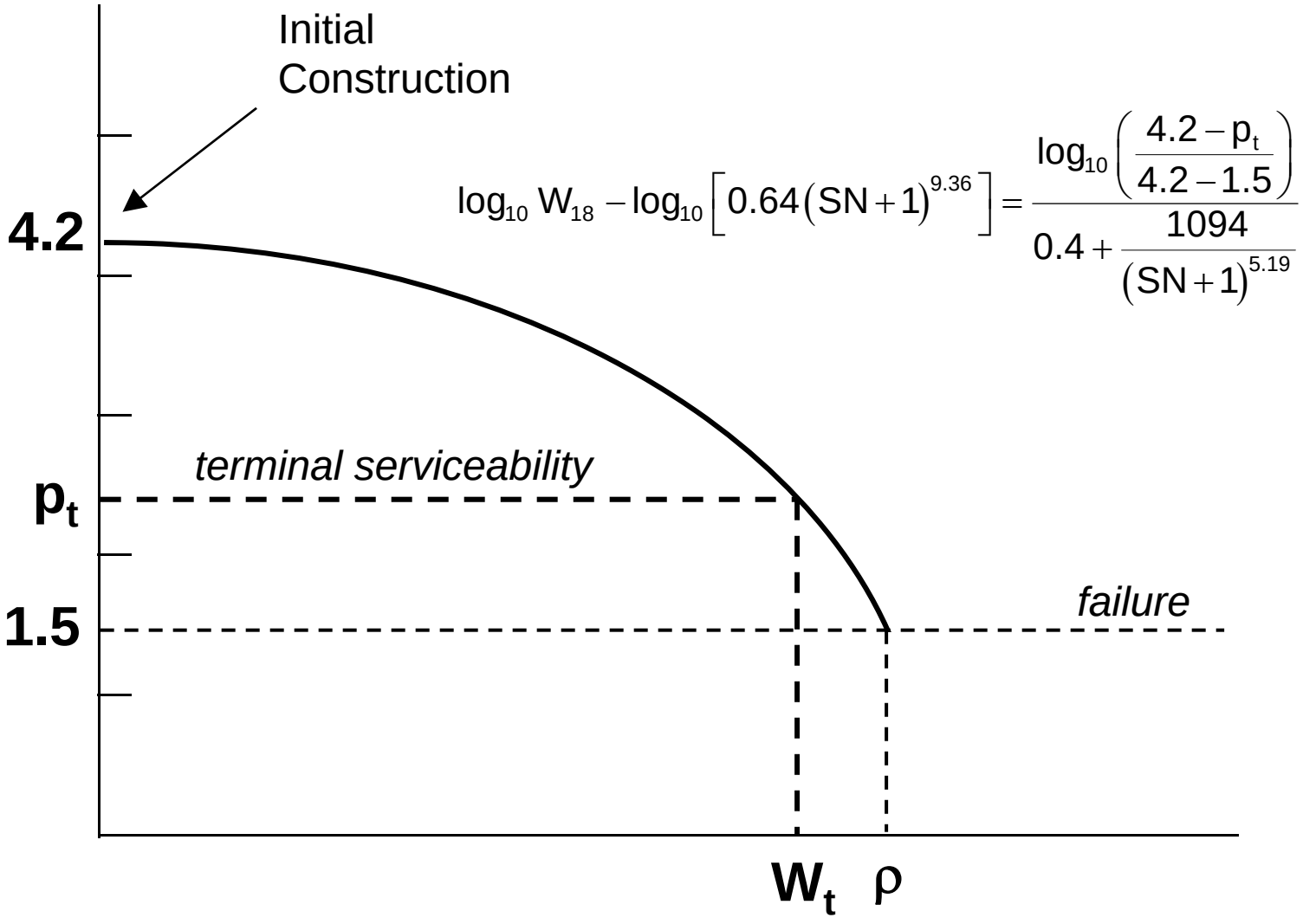
Pavement Performance



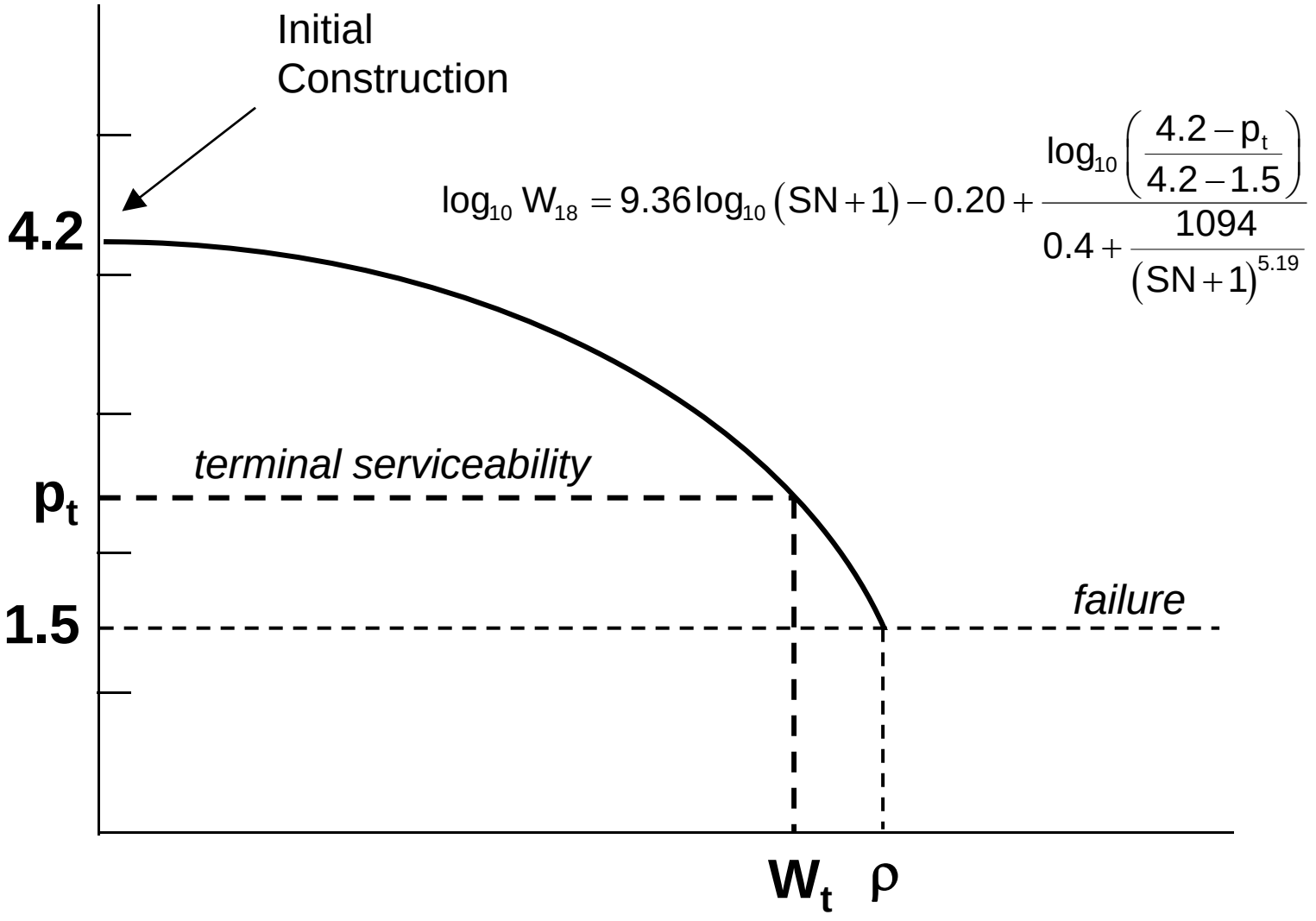
Pavement Performance



Pavement Performance



Pavement Performance



Flexible Performance

$$\log_{10} W_{18} = 9.36 \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left(\frac{4.2 - p_t}{4.2 - 1.5}\right)}{0.4 + \frac{1094}{(SN+1)^{5.19}}}$$

1966

AASHO Road Test

Climate

Average Mean Temperature (July)	24.5°C (76°F)
Average Mean Temperature (January)	-2.8°C (27°F)
Annual Average Rainfall	837 mm (34 in)
Average Depth of Frost (for fine-grained soil)	711 mm (28 in)

AASHO Road Test

Subgrade

Soil Classification	A-6
Percent Passing a #200 Sieve	82%
Liquid Limit	31%
Plasticity Index	16%
Average Degree of Saturation	85%
Average CBR	2.9

Flexible Performance

$$\log_{10} W_{18} = 9.36 \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left(\frac{4.2 - p_t}{4.2 - 1.5}\right)}{0.4 + \frac{1094}{(SN+1)^{5.19}}} + \log\frac{1}{R} + 0.372(S_i - 3.0)$$

Subgrade Support Factor

Regional Climate Factor

1972

Regional Factor

Condition	**R value**
Roadbed materials frozen to a depth of 5 in. or more (winter)	0.2 – 1.0
Roadbed materials dry (summer and fall)	0.5 – 1.5
Roadbed materials wet (spring thaw)	4.0 – 5.0

Regional Factor

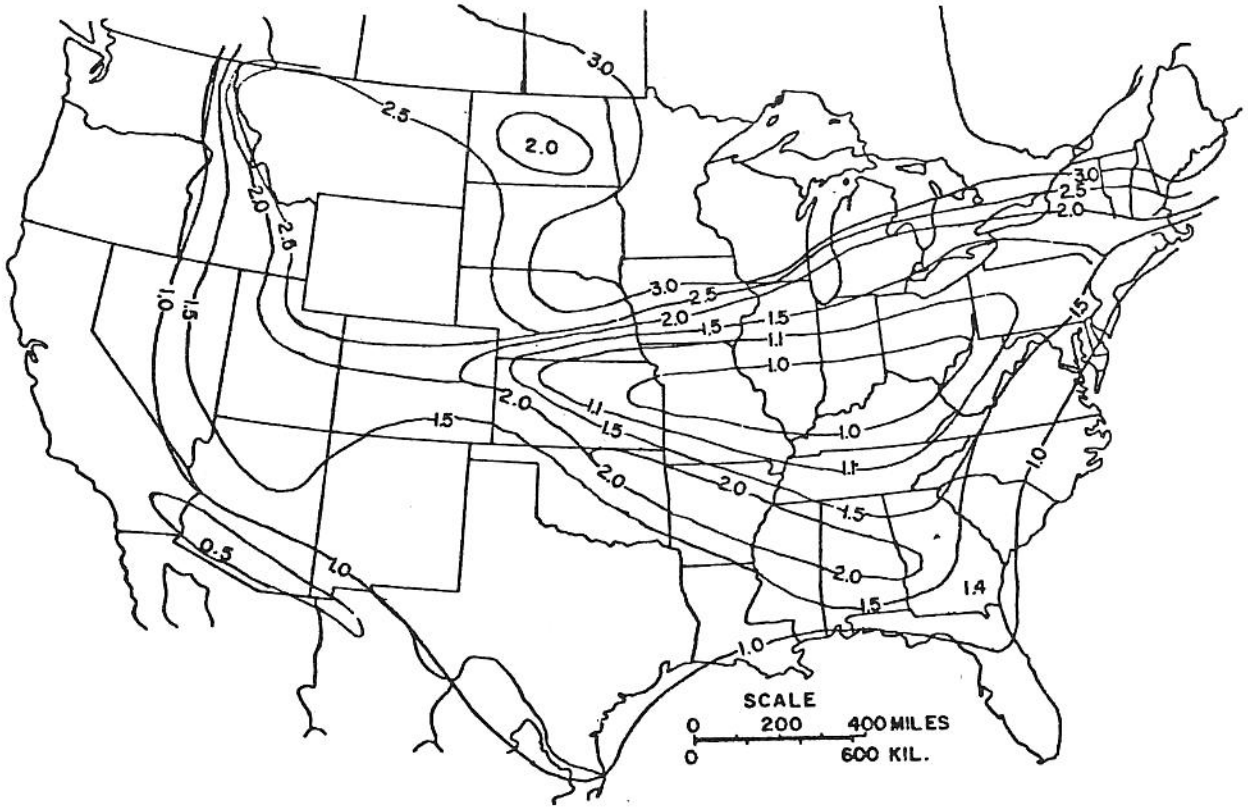
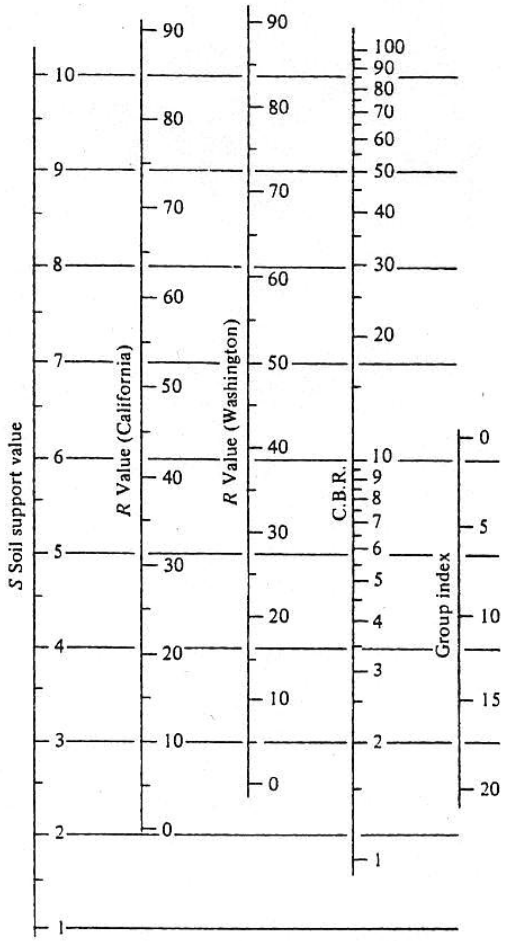


Figure 15.2. Generalized regional map of the United States. (From Van Til et al., NCHRP 128.)

Soil Support Value



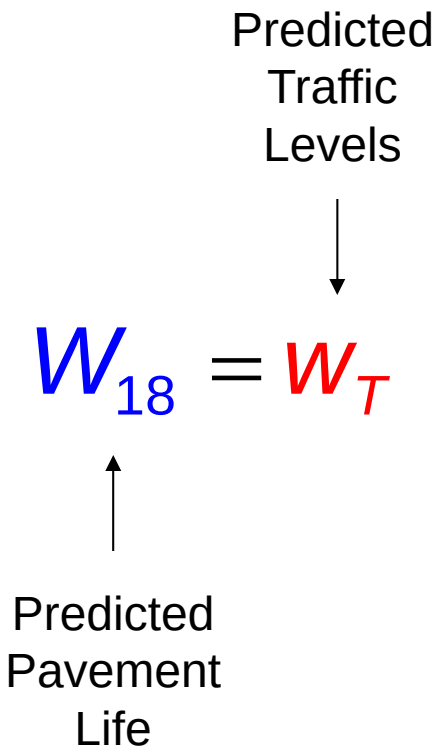
Flexible Performance

$$\log_{10} W_{18} = 9.36 \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left(\frac{4.2 - p_t}{4.2 - 1.5}\right)}{0.4 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \log_{10}(M_R) - 8.07$$

1986

Seasonally Adjusted Resilient Modulus

Design Equation



Design Equation

Predicted Traffic Levels

$$\log_{10} W_{18} = \log_{10} w_T$$

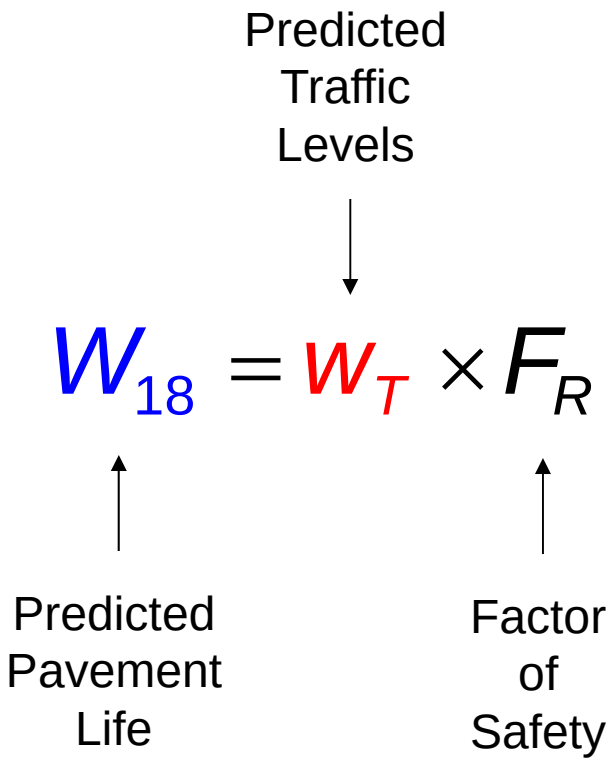
Predicted Pavement Life

Predicted Pavement Life

$$\log_{10} w_T = 9.36 \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left(\frac{4.2-p_t}{4.2-1.5}\right)}{0.4 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \log_{10}(M_R) - 8.07$$

Reliability

Design Equation w/ FS



Design Equation w/ FS

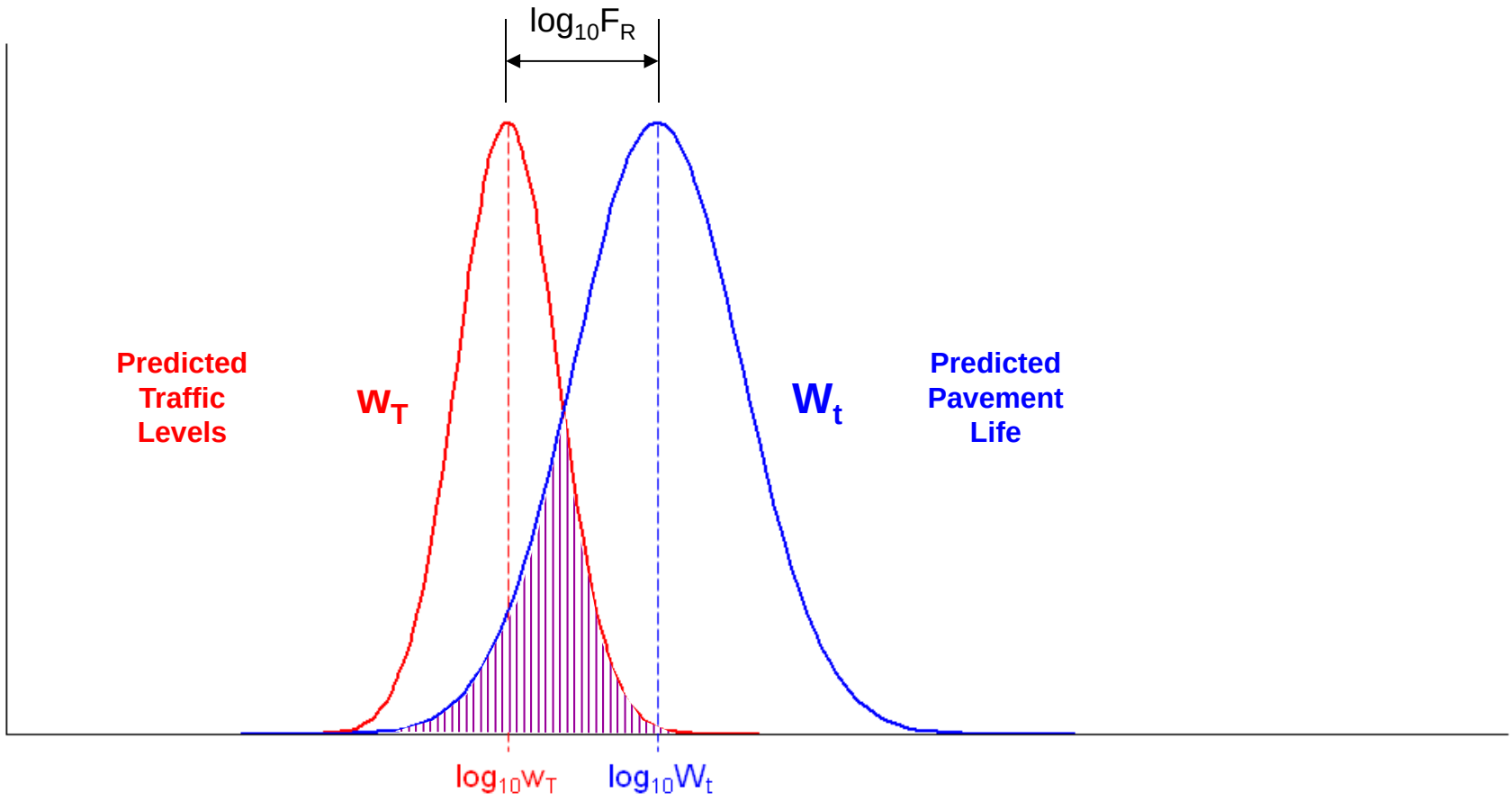
Predicted Traffic Levels

$$\log_{10} W_t = \log_{10} w_T + \log_{10} F_R$$

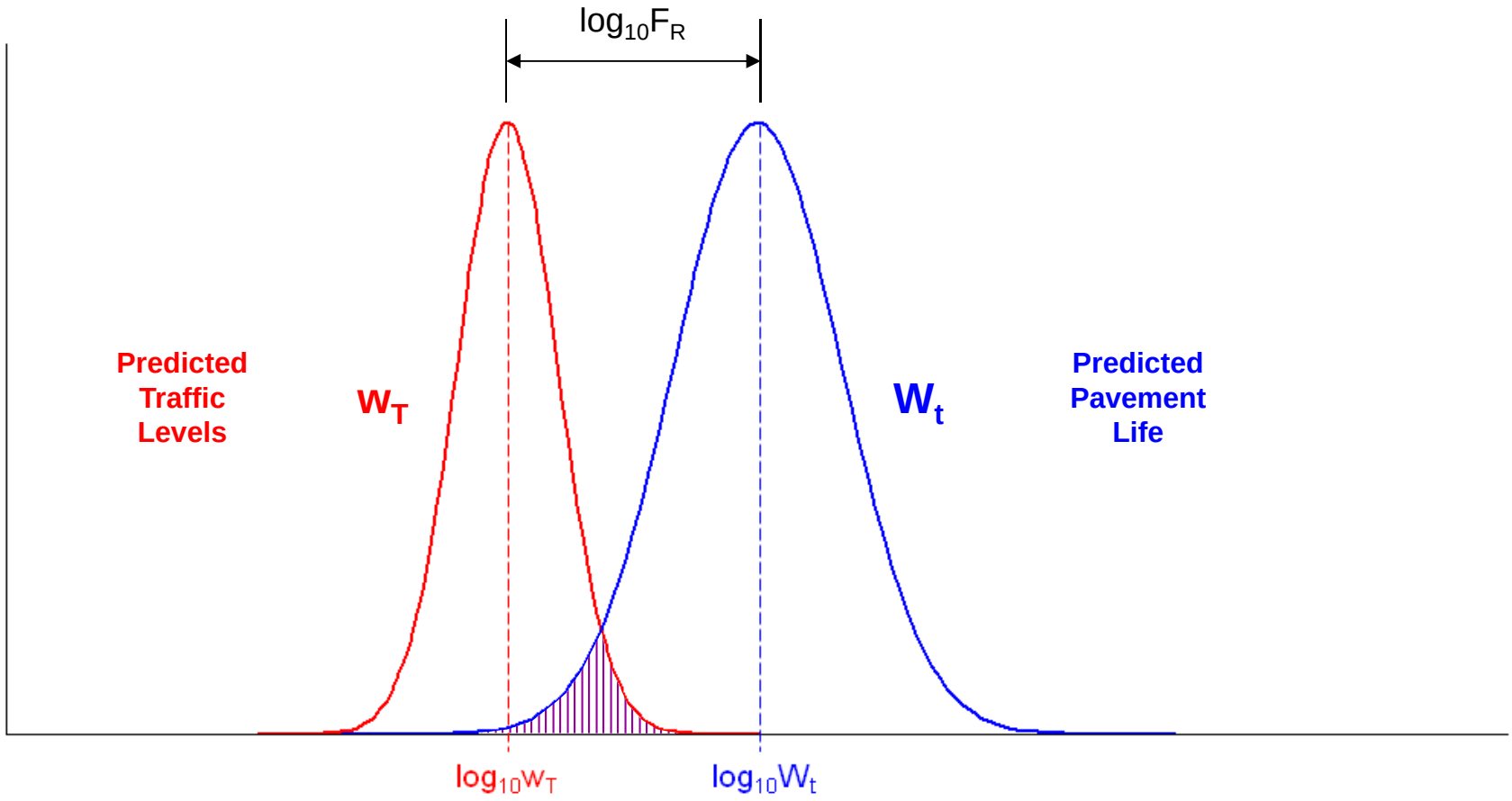
Predicted Pavement Life

Factor of Safety

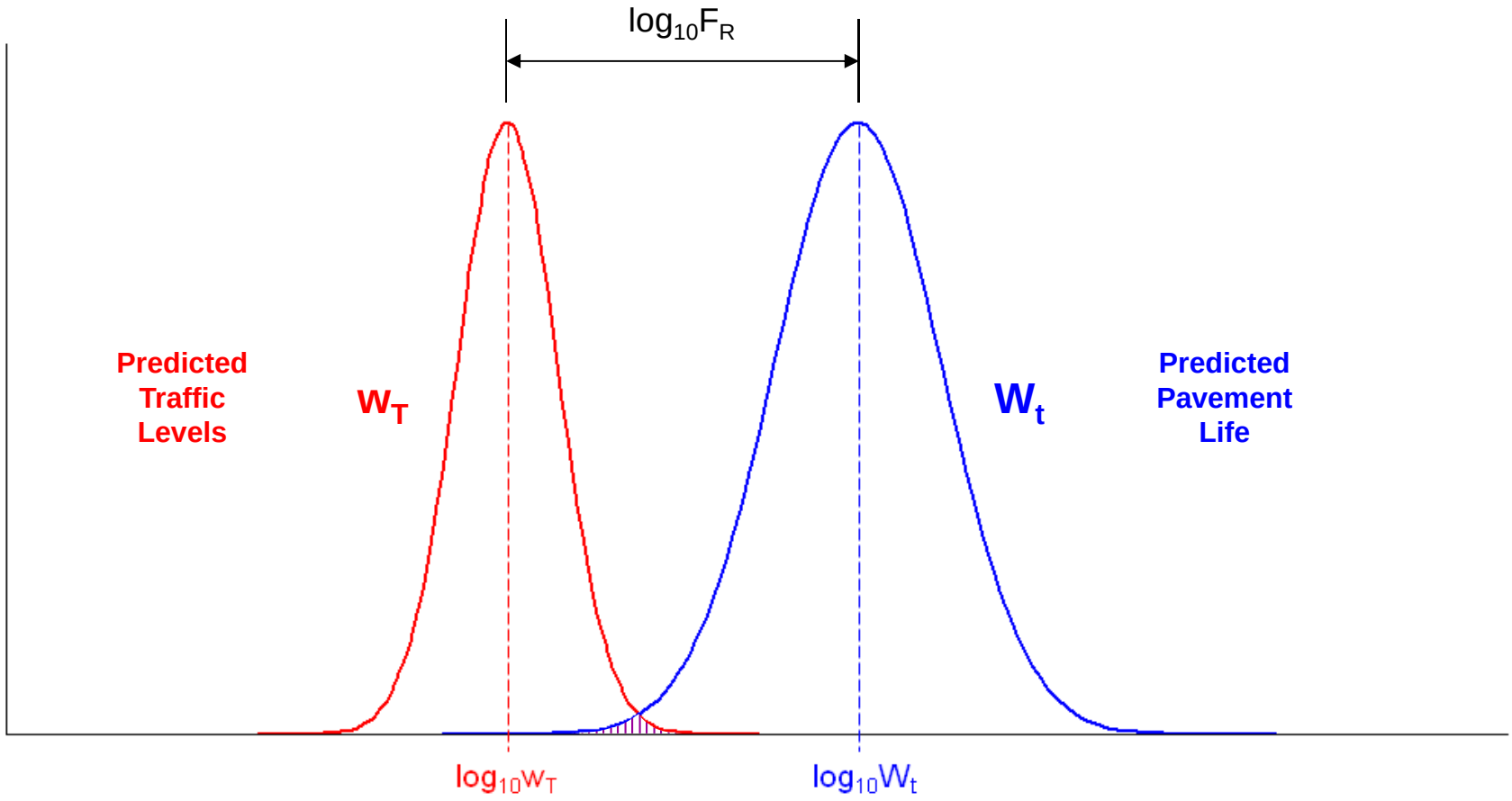
Reliability



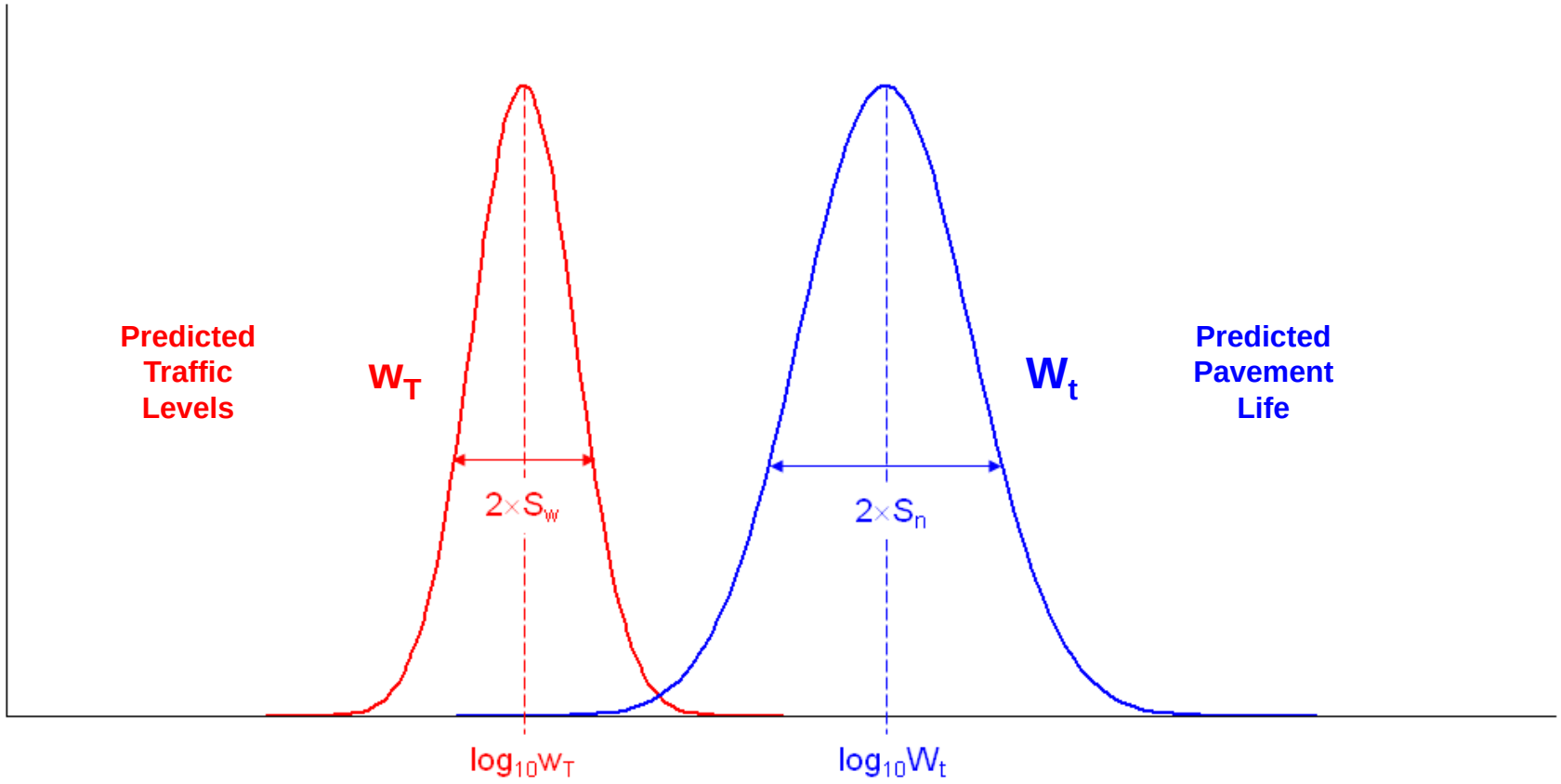
Reliability



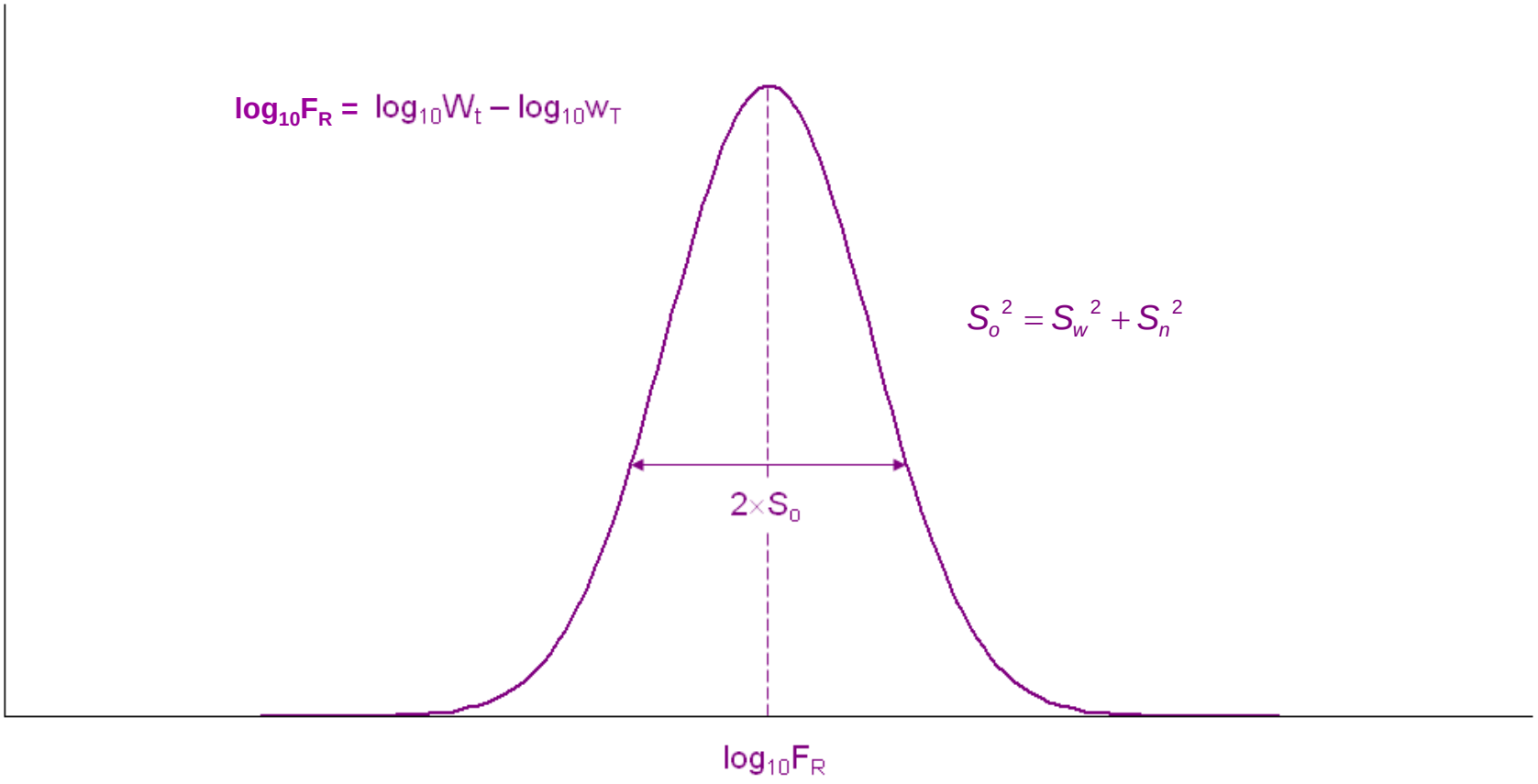
Reliability



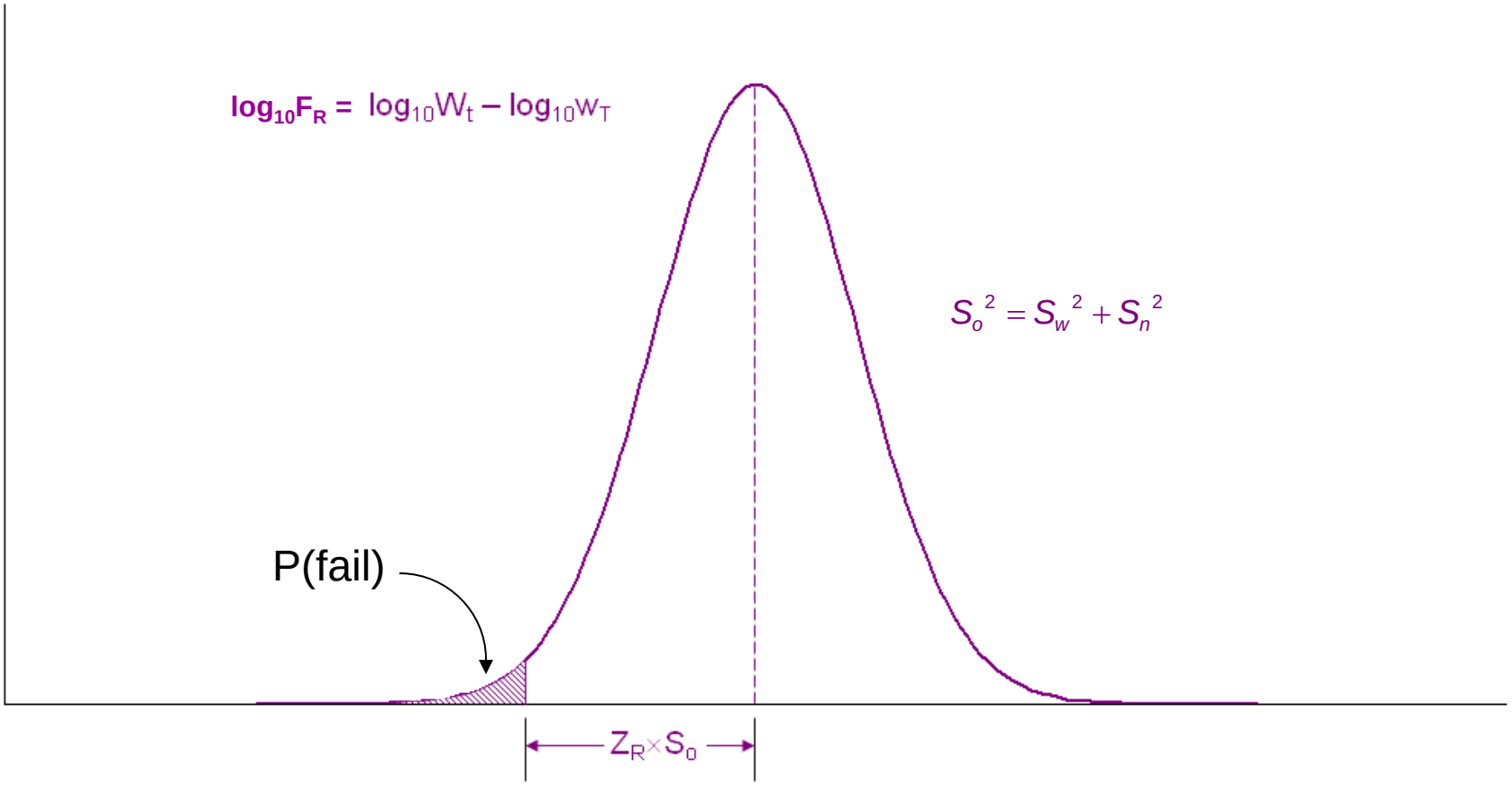
Reliability



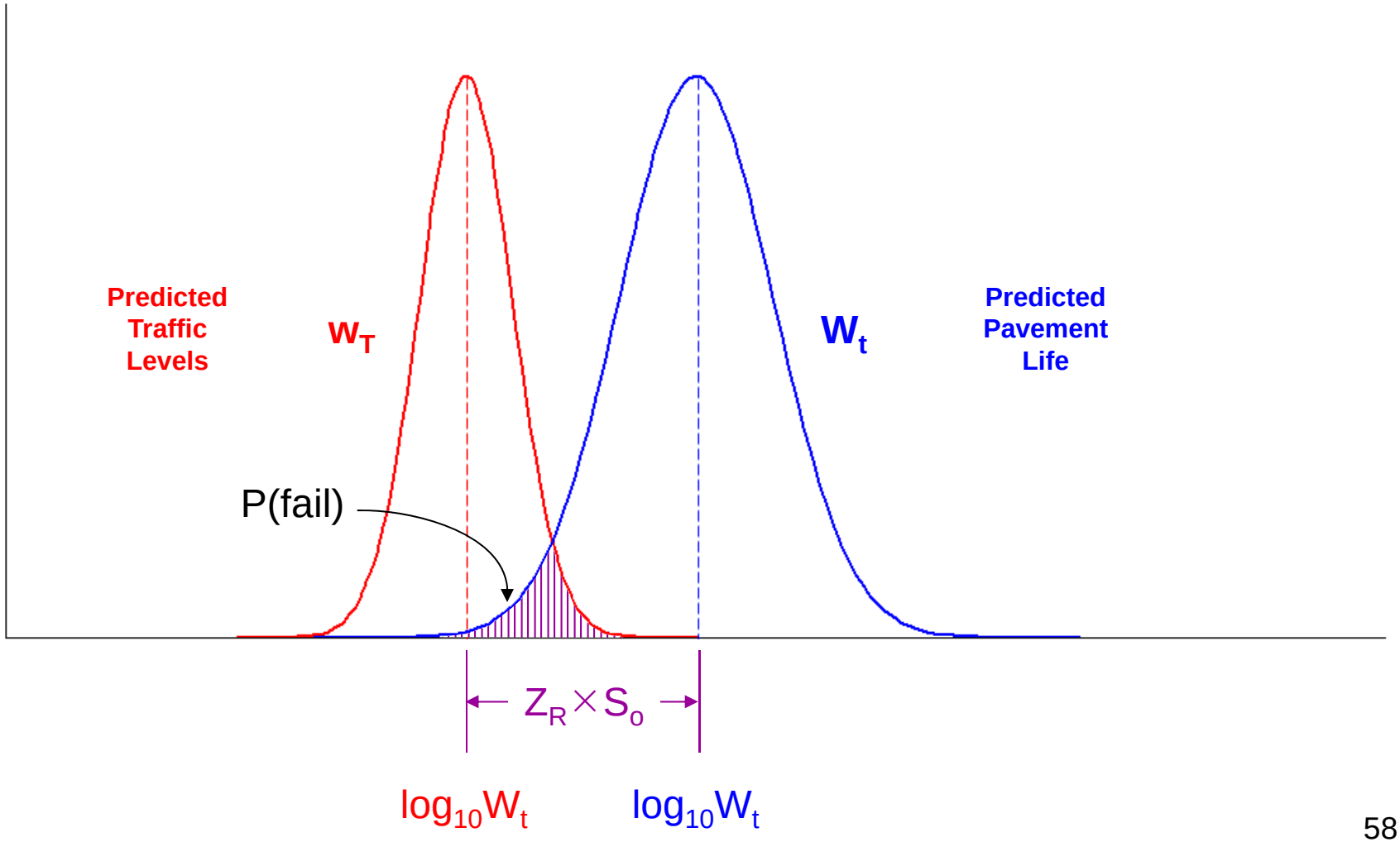
Reliability



Reliability



Reliability



Design Equation

Reliability

$$\log_{10} W_{18} = Z_R S_0 + 9.36 \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left(\frac{4.2-p}{4.2-1.5}\right)}{0.4 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \log_{10}(M_R) - 8.07$$

1993

Recommended Reliability

Functional Classification	Urban	Rural
Interstate and Other Freeways	85 – 99.9%	80 – 99.9%
Principal Arterials	80 – 99%	75 – 99%
Collectors	80 – 95%	75 – 95%
Local	50 – 80%	50 – 80%

Reliability

Reliability (%)	Z_R
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

Reliability (%)	Z_R
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

Standard Deviations

Source	**Flexible**	**Rigid**
AASHO Road Test S_n	0.35	0.25
AASHO Road Test S_o	0.45	0.35
Typical Range for S_o	0.40 – 0.50	0.35 – 0.40