

**RELIABILITY**  
**of**  
**WIM DATA**

Subtitle:

Why can't traffic data people and pavement design people just get together?



Reliability is a measure of the degree to which a process or system performs its function without error

# RELIABILITY

**Decreases as uncertainty increases**

**Zero Uncertainty > Reliability = 100 %**

**100% Uncertainty > Reliability = 0 %**

# **Appendix EE: “Reliability and Variance Estimates”**

**Proposed AASHTO Guide for**

**Design of Pavement Structures**

**NCHRP Project 20-7/24**

**May 1985**

# Recommended Level of Reliability, R (%)

**Functional**



**Classification**

	<b>Urban</b>	<b>Rural</b>
<b>Interstate and other freeways</b>	<b>85 - 99.9</b>	<b>80 - 99.9</b>
<b>Principal arterials</b>	<b>80 - 99</b>	<b>75 - 95</b>
<b>Collectors</b>	<b>80 - 95</b>	<b>75 - 95</b>
<b>Local</b>	<b>50 - 80</b>	<b>50 - 80</b>

$$W_t = W_T * F_R$$

where  $W_t$  = the number of ESAL's for which the pavement is designed and is the expected value of the number of actual ESAL's applied to the pavement before it reaches terminal serviceability

$W_T$  = the design period prediction of ESAL's

$F_R$  = the reliability design factor

$$F_R = 10^{-Z_R * S_0}$$

where  $F_R$  is the reliability factor

$S_0$  is the aggregate standard deviation of all factors and variables contributing to the variability in the design

$Z_R$  is the standard normal deviate

**Standard normal deviate ( $Z_R$ ) values corresponding to selected reliability levels.**

<b>Reliability, R (percent)</b>	<b>Standard Normal Deviate, <math>Z_R</math></b>
<b>50</b>	<b>- 0.000</b>
<b>60</b>	<b>- 0.253</b>
<b>70</b>	<b>- 0.524</b>
<b>75</b>	<b>- 0.674</b>
<b>80</b>	<b>- 0.841</b>
<b>85</b>	<b>- 1.037</b>
<b>90</b>	<b>- 1.282</b>
<b>95</b>	<b>- 1.645</b>
<b>99</b>	<b>- 2.327</b>
<b>99.9</b>	<b>- 3.090</b>
<b>99.99</b>	<b>- 3.750</b>

$$S_o^2 = S_N^2 + S_w^2$$

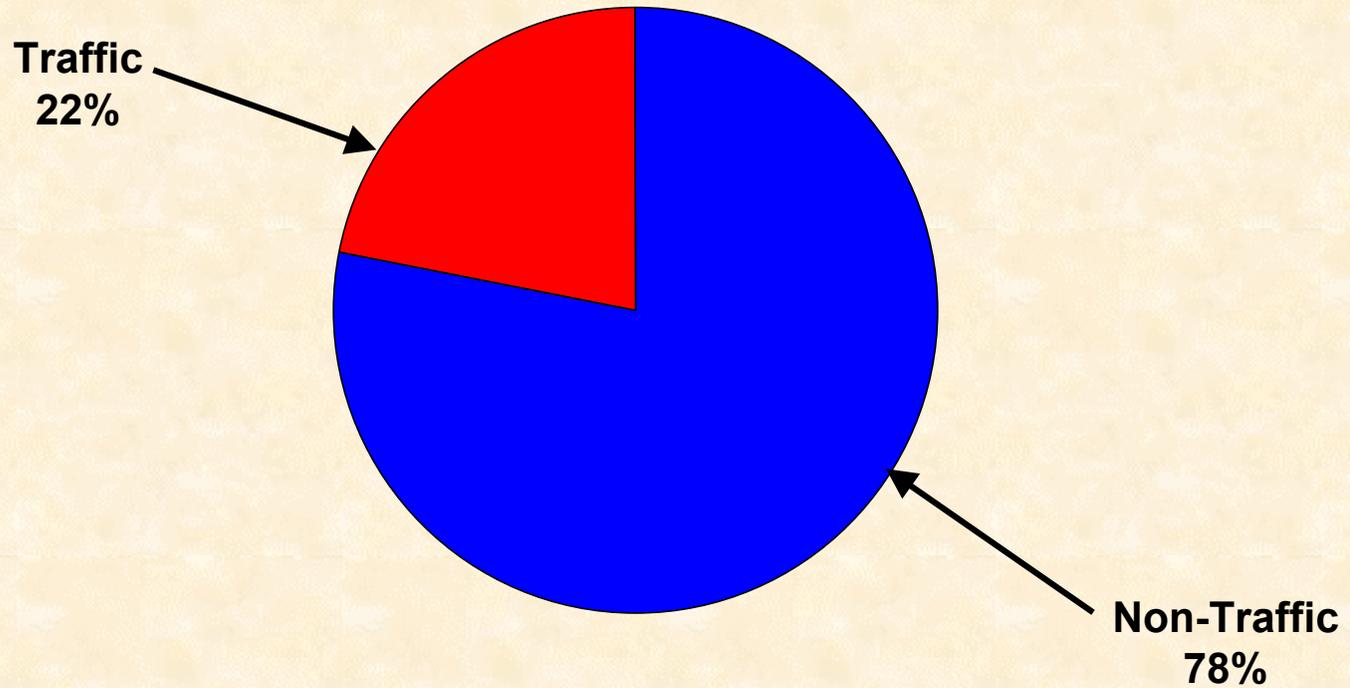
**Where**

**$S_o^2$  is the overall variance of all factors and variables contributing chance variability in the design**

**$S_N^2$  is the aggregate variance of the effects of all non- traffic factor variances contributing to the chance variability in the predicted pavement performance versus the actual pavement performance**

**$S_w^2$  is the aggregate variance of the effects of all traffic factor variances contributing to the chance variability in the predicted pavement performance versus the actual pavement performance**

## Distribution of Data Variability to Traffic and Non-Traffic Factors



**Aggregate non- traffic variance ( $S_N^2$ ) was estimated to be 0.1128**

**The AASHTO Guide asserts that the range for the aggregate variance of the traffic variables ( $S_w^2$ ) is from 0.0225 to 0.0429**

**Total variance ( $S_o^2$ ) for rigid pavement lies between 0.1353 and 0.1557**

**The specific variance values given previously and used in the AASHTO Guide for each of the traffic parameters were taken from reported research results which indicated that:**

- 1. The standard deviation of the AADT estimate is within 6% of the AADT initial estimate.**
- 2. The standard deviation of the traffic growth factor is within 4% of the initial estimate.**
- 3. The standard deviation of the percent heavy trucks is within 4% of its initial estimate.**
- 4. The average number of axles per truck is within 4% of its initial estimate.**
- 5. The standard deviation of the average ESAL per axle is within 15% of its initial estimate**

	WIM SITE						
	1	2	3	4	5	6	7
$CV^2(\text{AADT})$	0.0117	0.0339	0.0070	0.0110	0.0094	0.0143	0.0368
$CV^2(\text{PCT})$	0.0203	0.0227	0.0196	0.0493	0.0389	0.0334	0.0434
$CV^2(\text{EF})$	0.5480	0.6067	0.4923	0.9923	0.5817	0.3670	0.5359
$CV^2(\text{LF})$	0.0251	0.0317	0.0309	0.0309	0.0309	0.0264	0.0278
$S_w^2$	0.1126	0.1294	0.1023	0.2017	0.1230	0.2683	0.1199
$S_n^2$	0.1128	0.1128	0.1128	0.1128	0.1128	0.1128	0.1128
$S_o^2$	0.2254	0.2422	0.2151	0.3145	0.2358	0.3811	0.2327

# Does It Really Matter?

Only if we don't want to underdesign  
or overdesign our pavements

Achieving the target reliability  
levels will require better data

Good data allow good decisions  
to be made.