

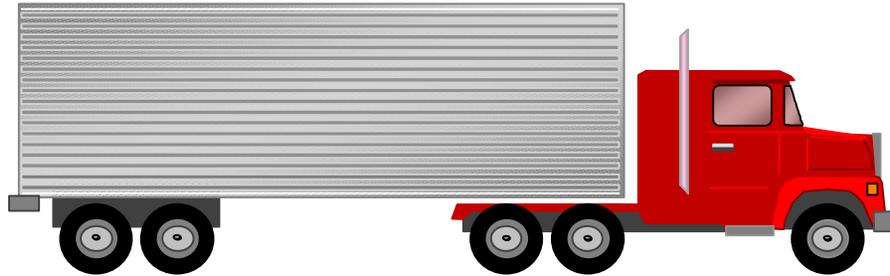
Weigh-In-Motion Data Requirements for Mechanistic Pavement Design

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Truck Volumes and Axle Weights Affect Performance



The way traffic loads are characterized for pavement design is changing

Presentation Objectives

- What is expected from WIM scales for mechanistic pavement design
- What changes in WIM data collection and reporting are needed to meet new demands

Traffic Load Characterization for Pavement Design

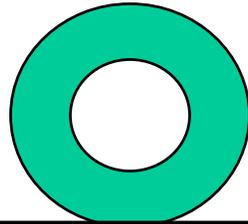
- Pavement design is becoming more sophisticated and is based on the calculation of strains and stresses
- Traffic load characterization is moving from Equivalent Single Axle Loads to axle load spectra
- 2002 Pavement Design Guide will accelerate the trend

Traditional Pavement Design

- Large empirical component
- Use of Single Equivalent Axle load concept to characterize traffic loads
- Limited use of axle spacing, tire pressures and similar characteristics
- Limited use of variation of traffic with time

Standard Axle

Weight: 80 kN (18,000 lb)

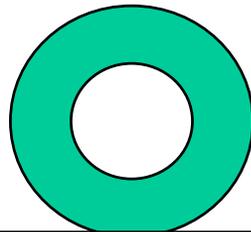


➤ **ESAL = 1.0**

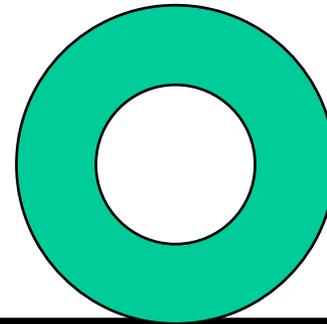
-
- **In US: 89 kN (20,000 lb)**
 - **In Canada: 98 kN (22,046 lb)**
 - **In Europe: 115 kN (26,850 lb)**

Comparison of Two Axle Loads

80 kN

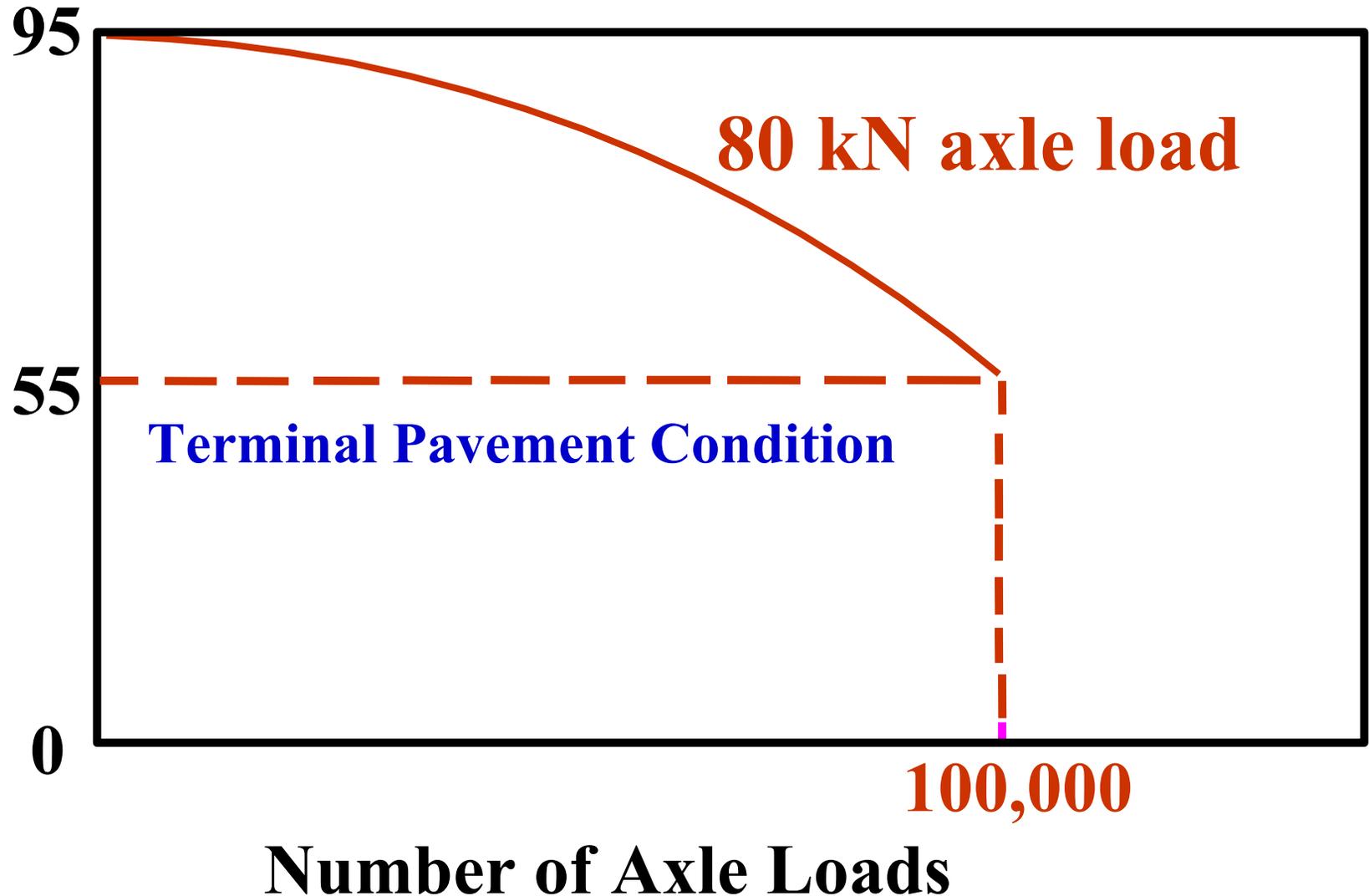


133 kN

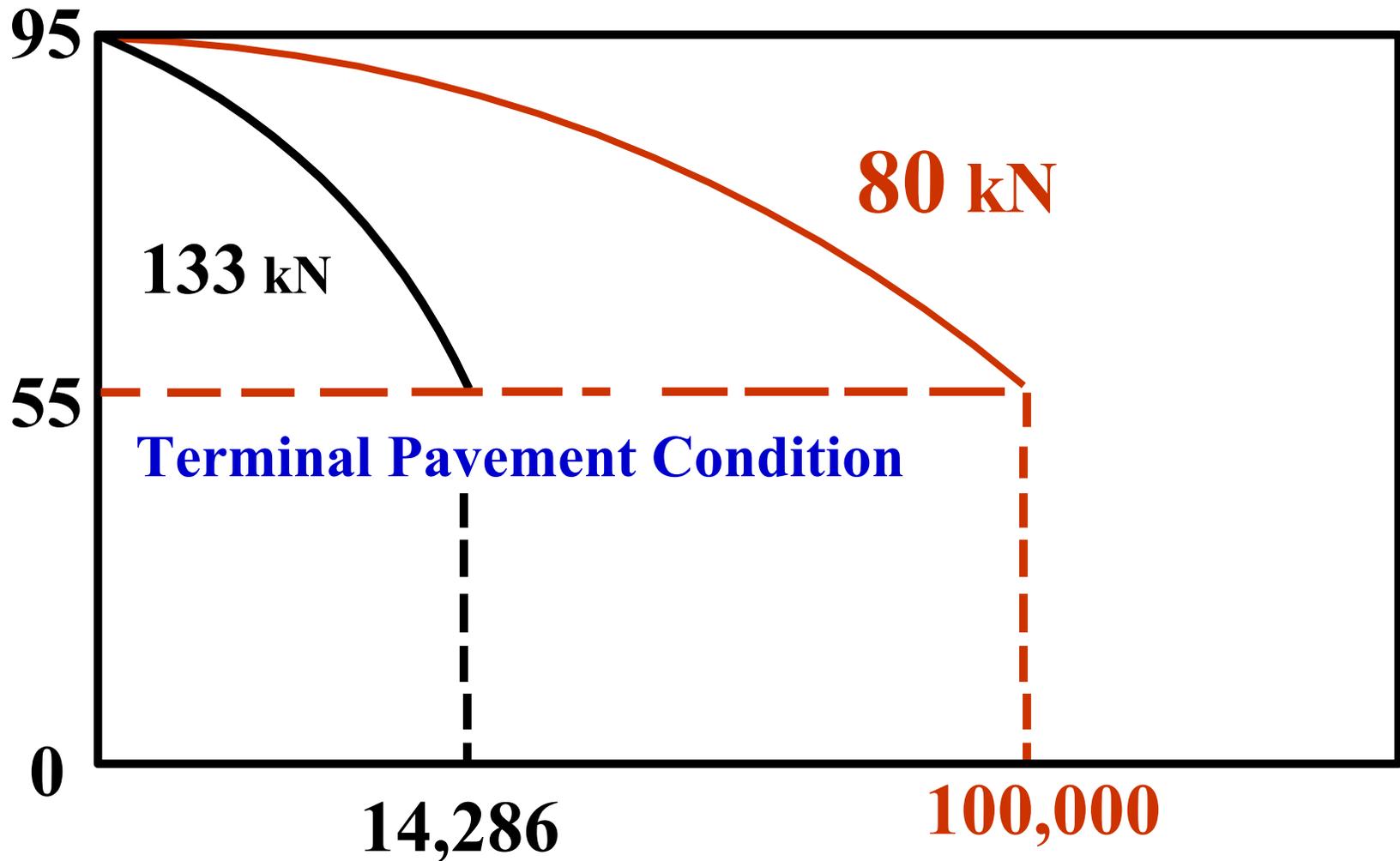


Pavement damage is expressed in terms of
Load Equivalency Factors

Pavement Performance vs Load

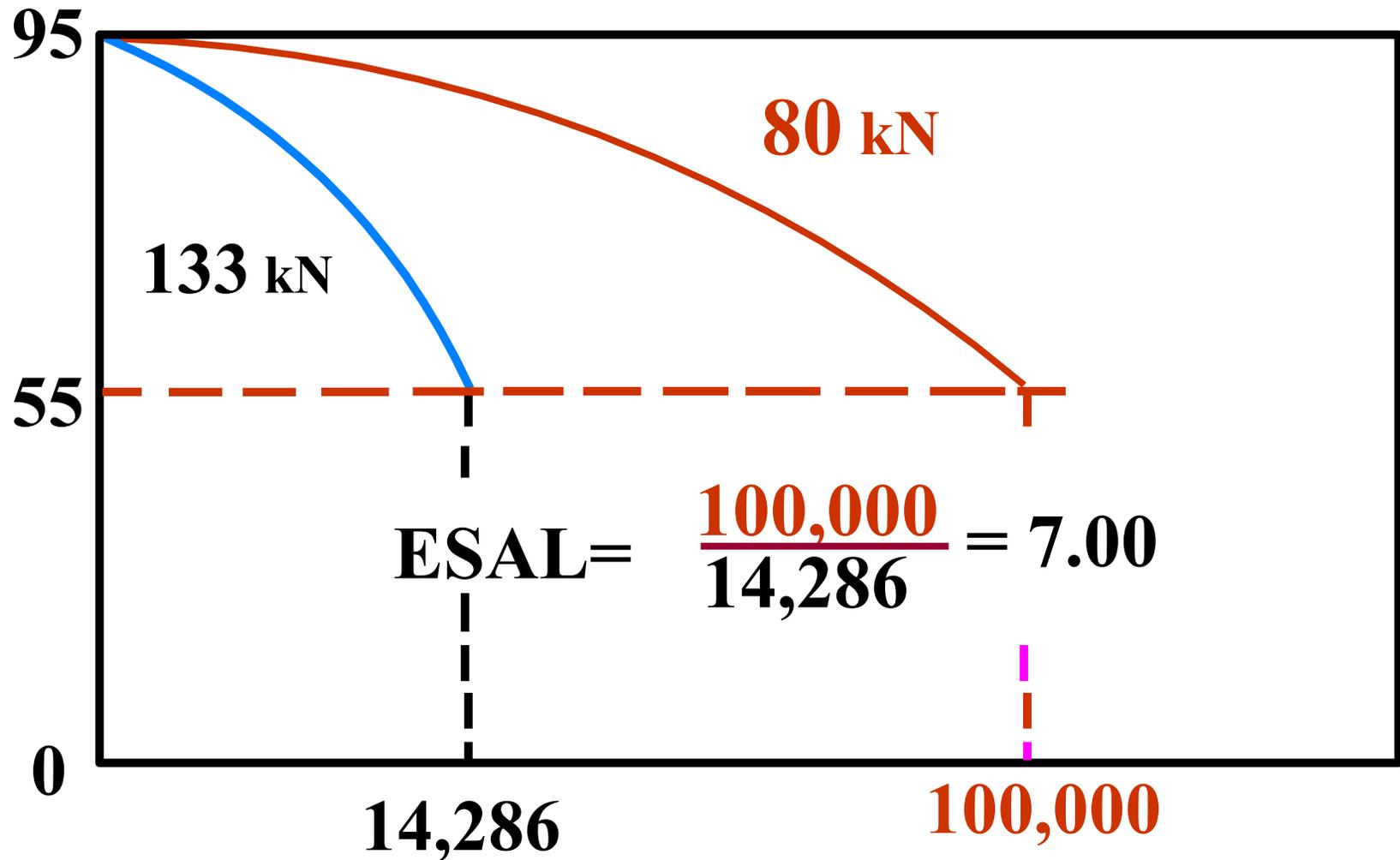


Pavement Performance vs Load



Number of Axle Loads *ICWIM 2002*

Equivalent Load

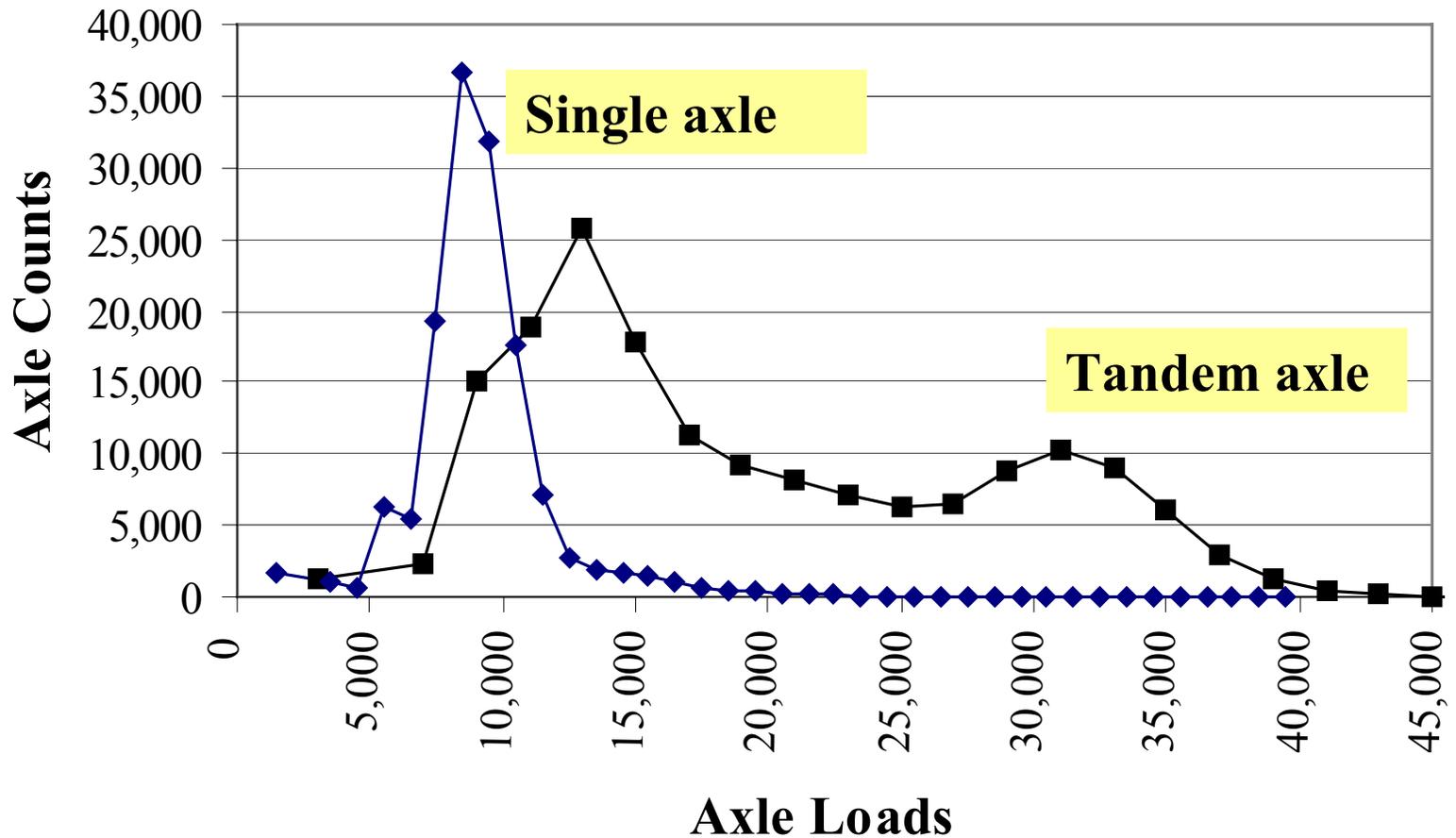


Number of Axle Loads *ICWIM 2002*

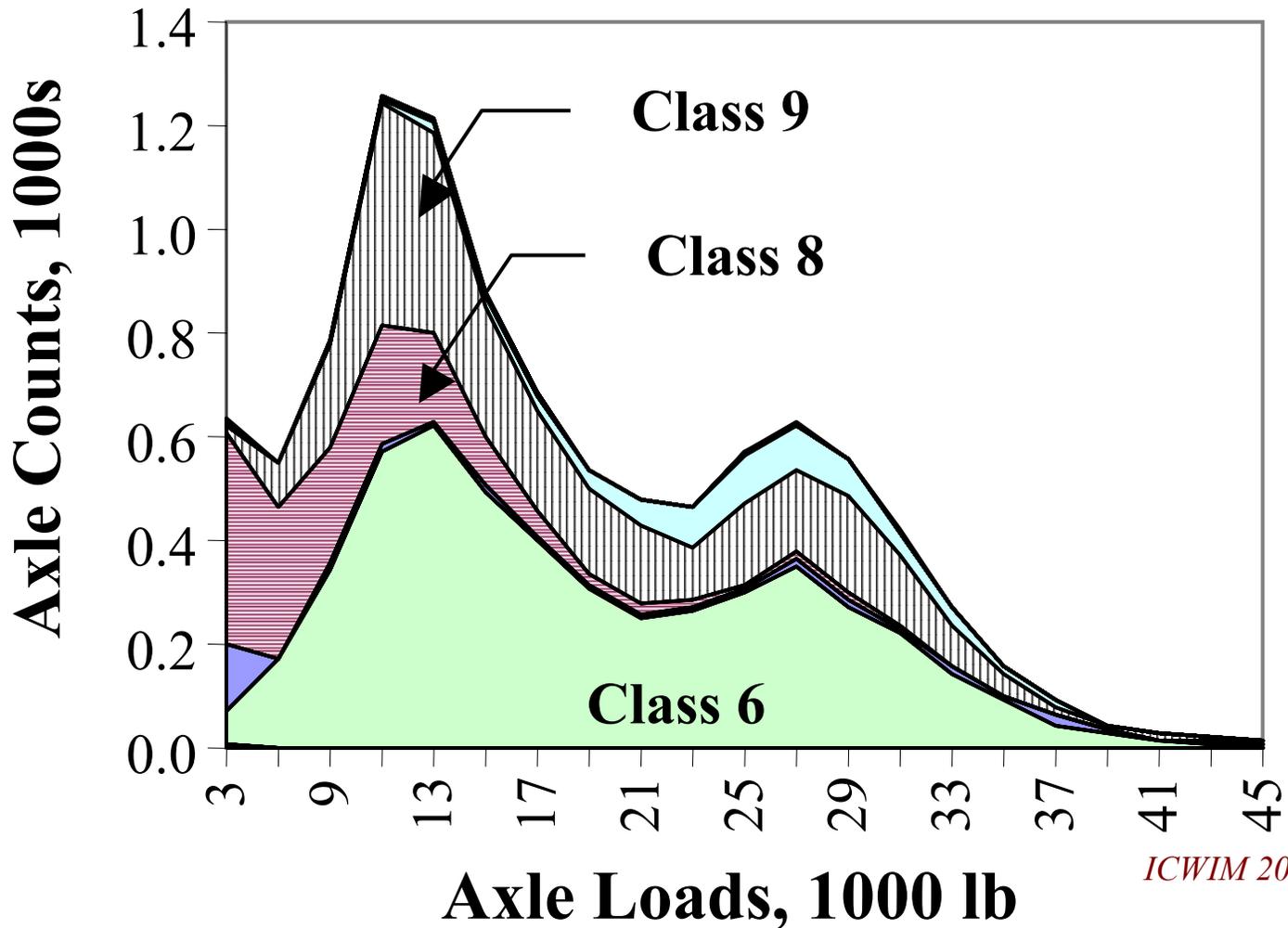
Mechanistic Pavement Design

- The use of axle loads in terms of axle load distributions
- Utilization of non-traditional pavement loading conditions
 - Tire pressures
 - Axle spacing, spacing of wheels
 - Multiple axles
- Traffic variation with time

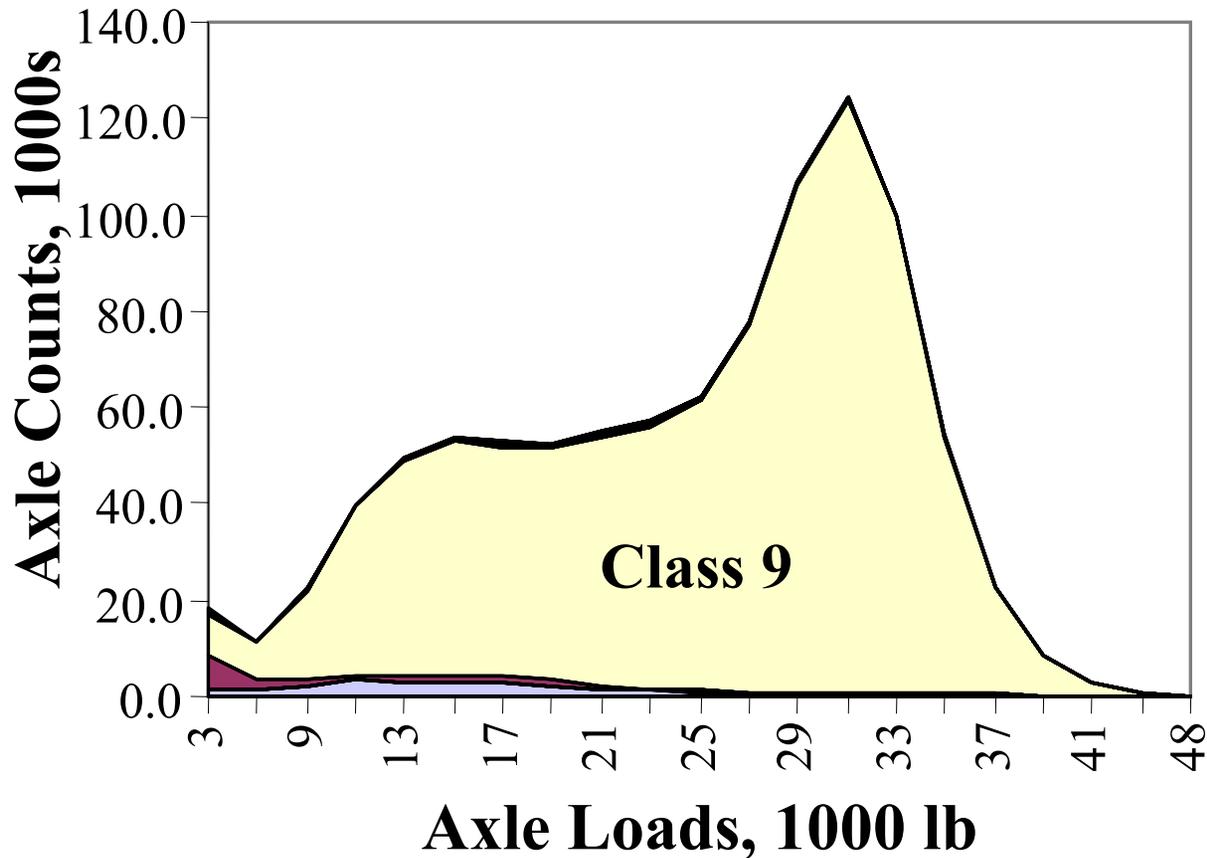
Axle Spectra Instead of ESALs



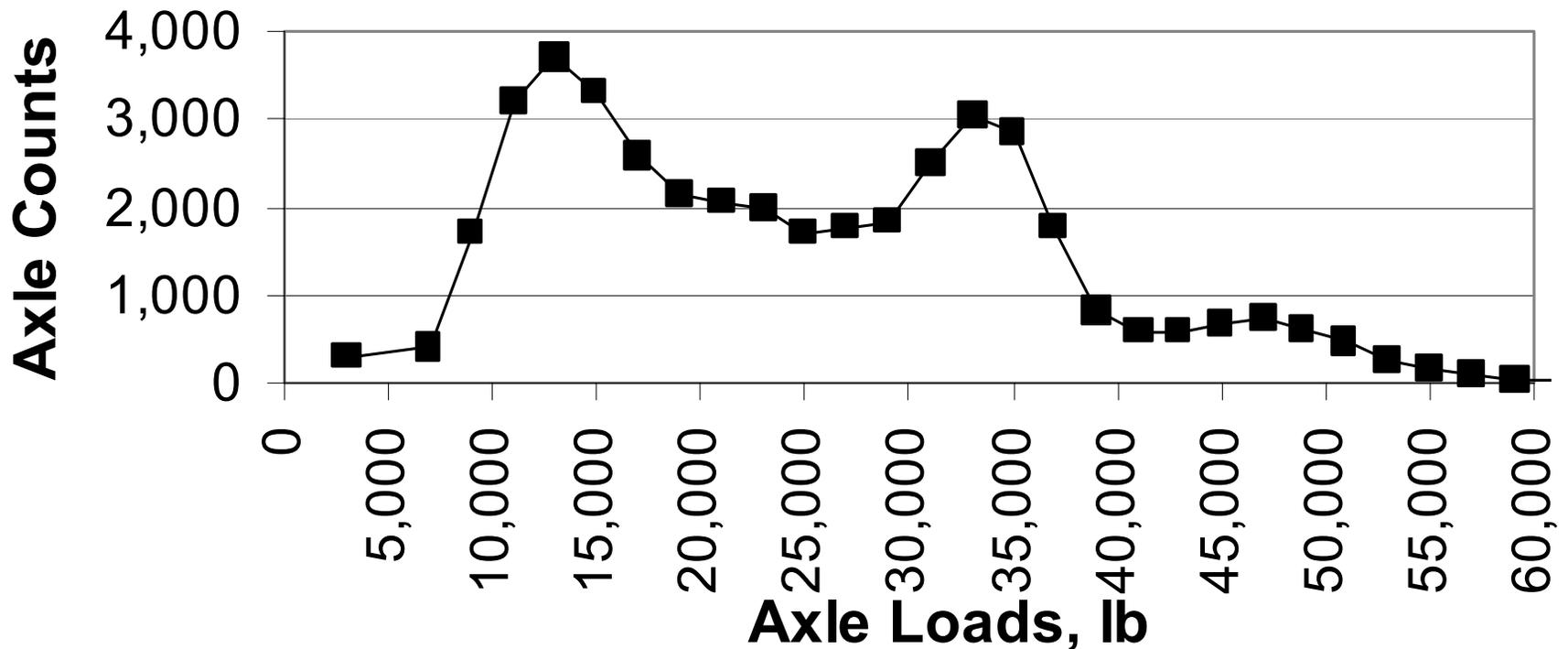
Axle Load Spectra for Tandem Axles, Rural Collector



Axle Load Spectra for Tandem Axles, Rural Interstate



Challenges Working with Axle Load Spectra



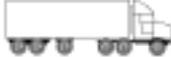
Challenges Working with Axle Load Spectra

- Axle load spectra are large
 - Single, tandem, tridem, quadruple
 - 25 or more load intervals per axle type
 - 9 truck types
- Little information is available on the typical characteristics of axle load spectra
- It makes sense to use graphical displays to compare spectra

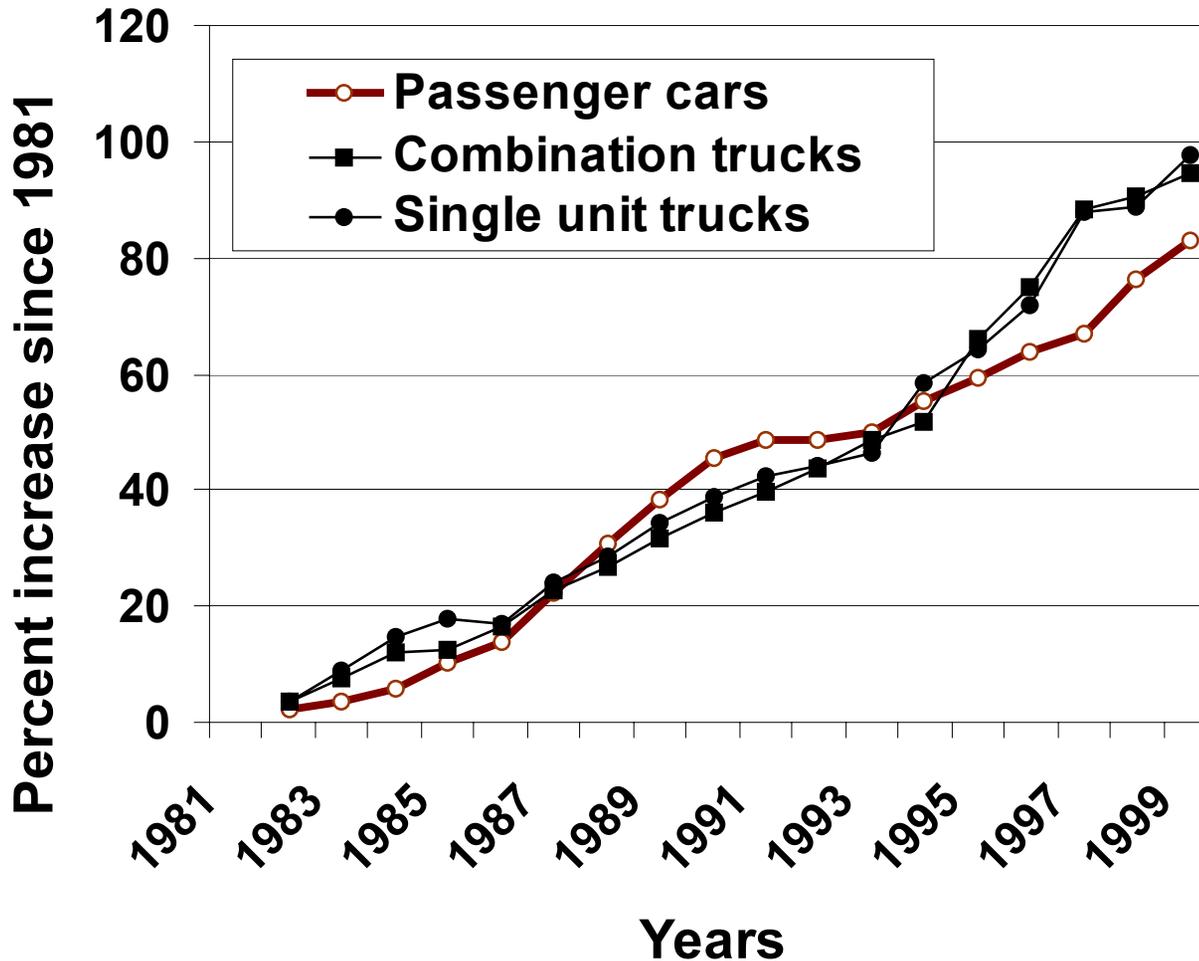
Traffic Characterization for 2002 Guide

- Truck volumes and growth in volumes
- Axle load spectra
- Truck technology
 - **Tire pressure**
 - **Axle spacing; dual tire spacing**
- Variation in axle loads
 - **Monthly**
 - **Hourly**

FHWA Truck Types

Category		Description
4		Buses
5		Two-Axle, Six-Tire, Single Unit Trucks
6		Three-Axle Single Unit Trucks
7		Four or More Axle Single Unit Trucks
8		Four or Less Axle Single Trailer Trucks
9		Five-Axle Single Trailer Trucks
10		Six or More Axle Single Trailer Trucks
11		Five or Less Axle Multi-Trailer Trucks
12		Six-Axle Multi-Trailer Trucks
13		Seven or More Axle Multi-Trailer Trucks

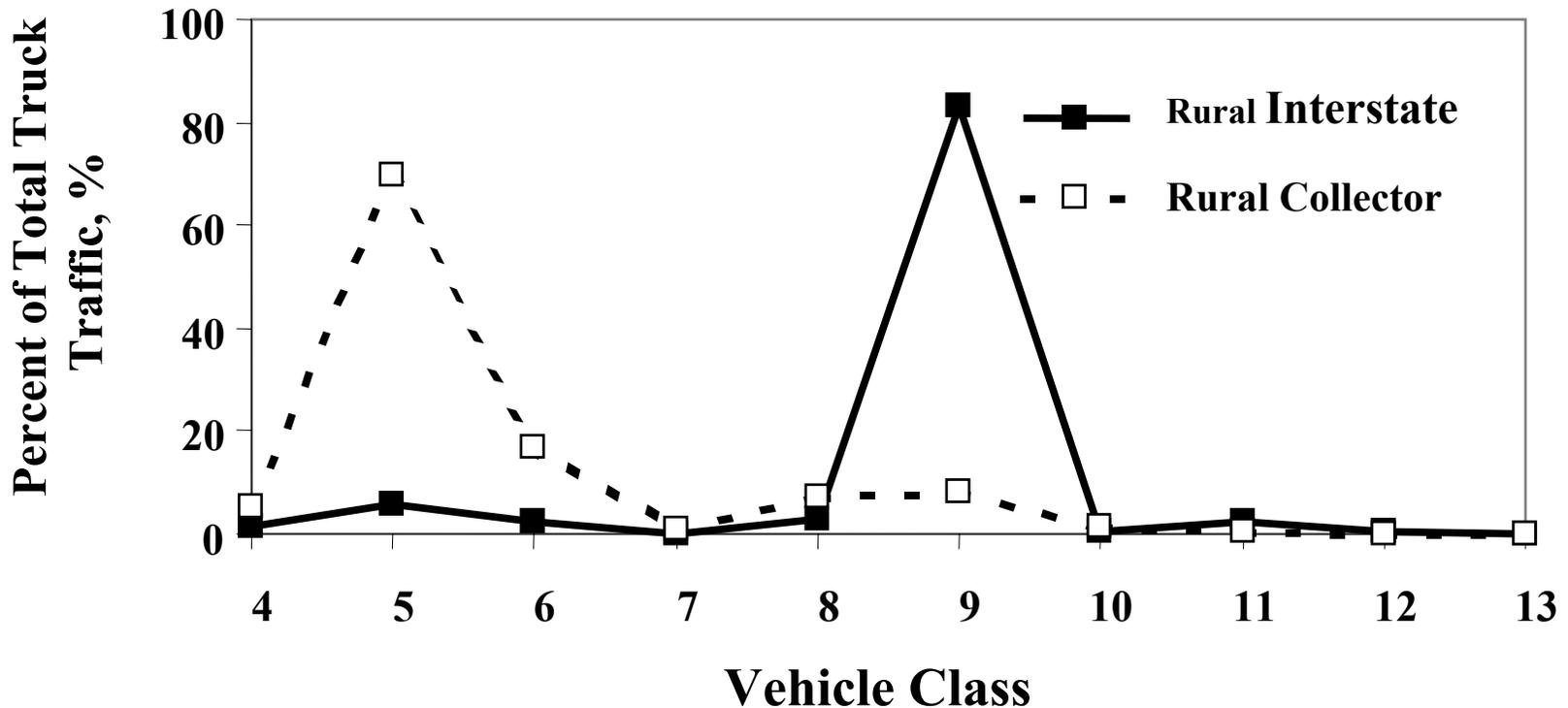
Increase in Vehicle Miles on Rural Interstates



After 1994

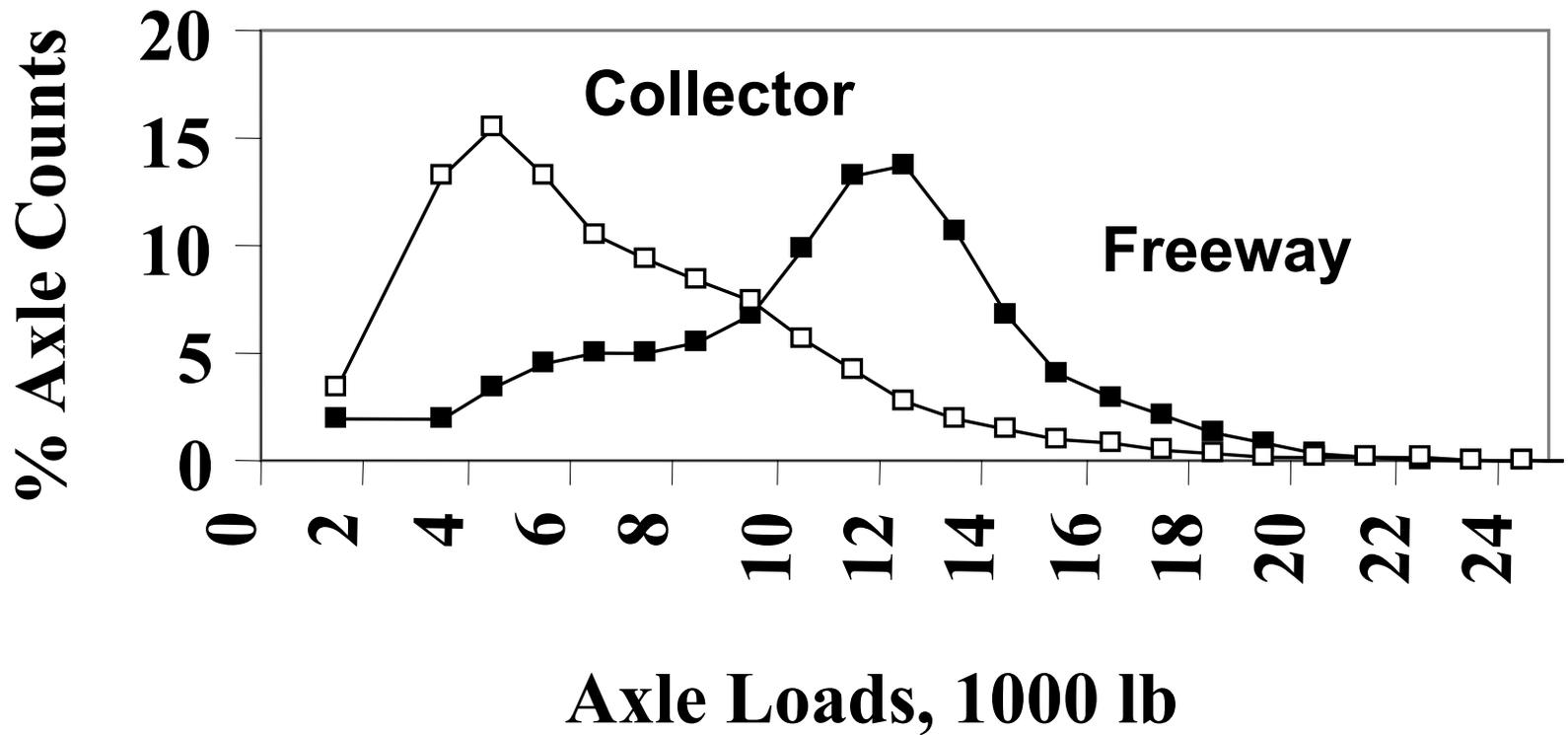
- 5.8% growth for heavy trucks
- 3.4% growth for cars

Distribution of Trucks by FHWA Class

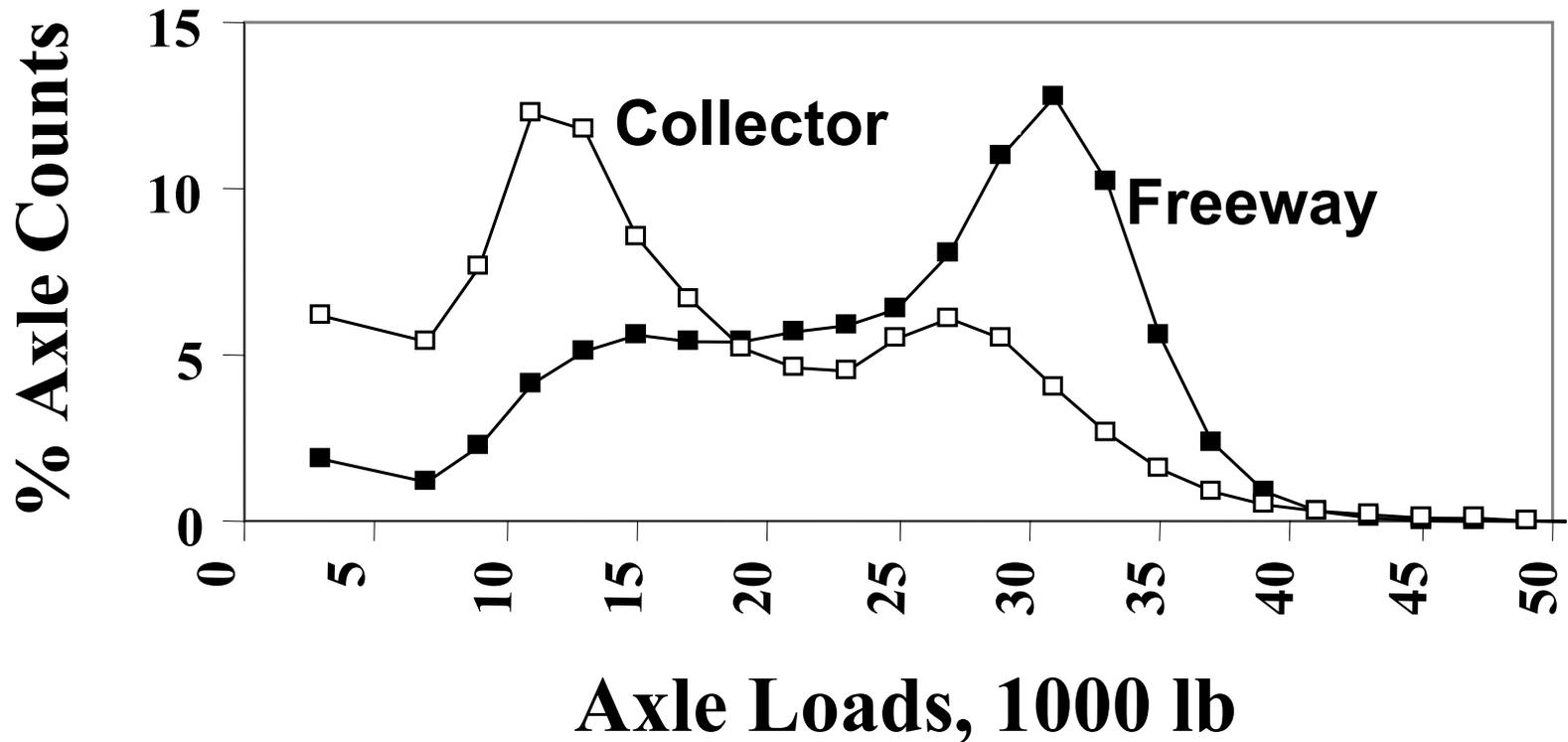


- Rural Interstates: 5-axle semi trailers dominate
- Rural collector: 2-axle trucks dominate

Difference in Axle Load Spectra for Single Axles



Difference in Axle Load Spectra for Tandem Axles

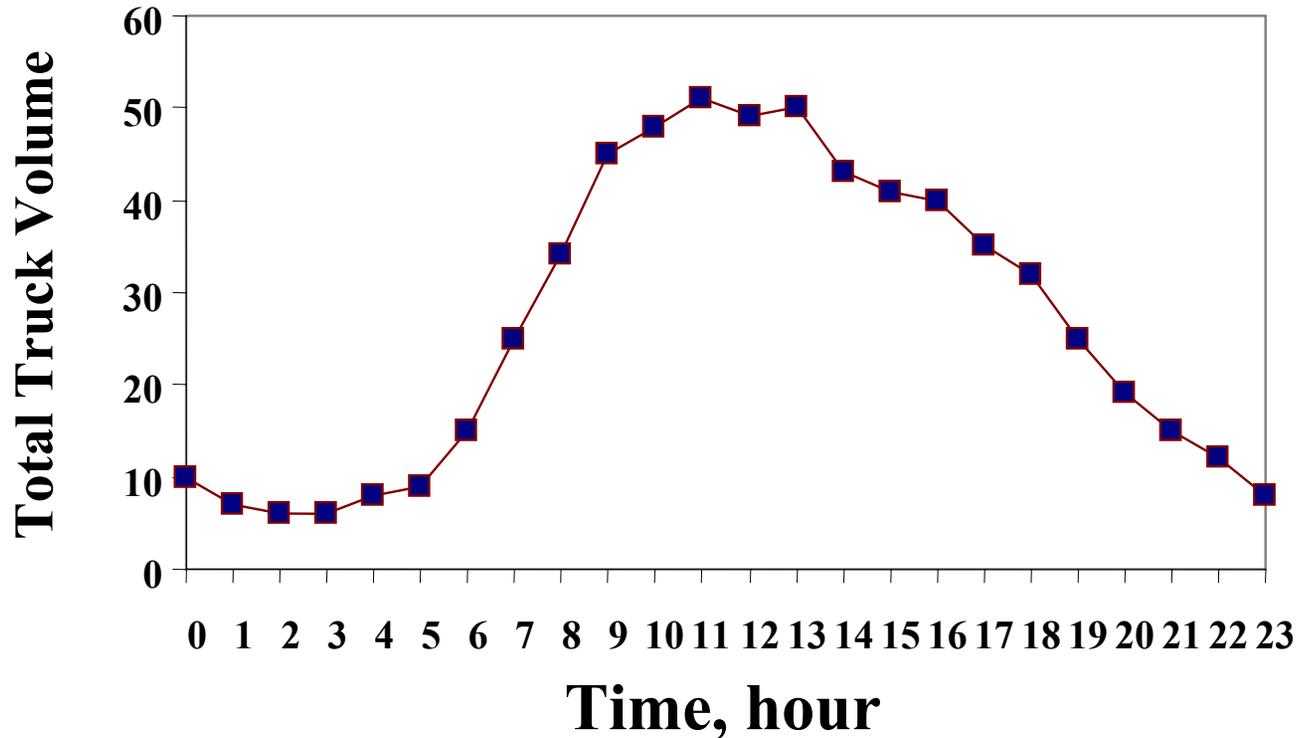


Variability of Traffic Flow

Variability in volumes and composition

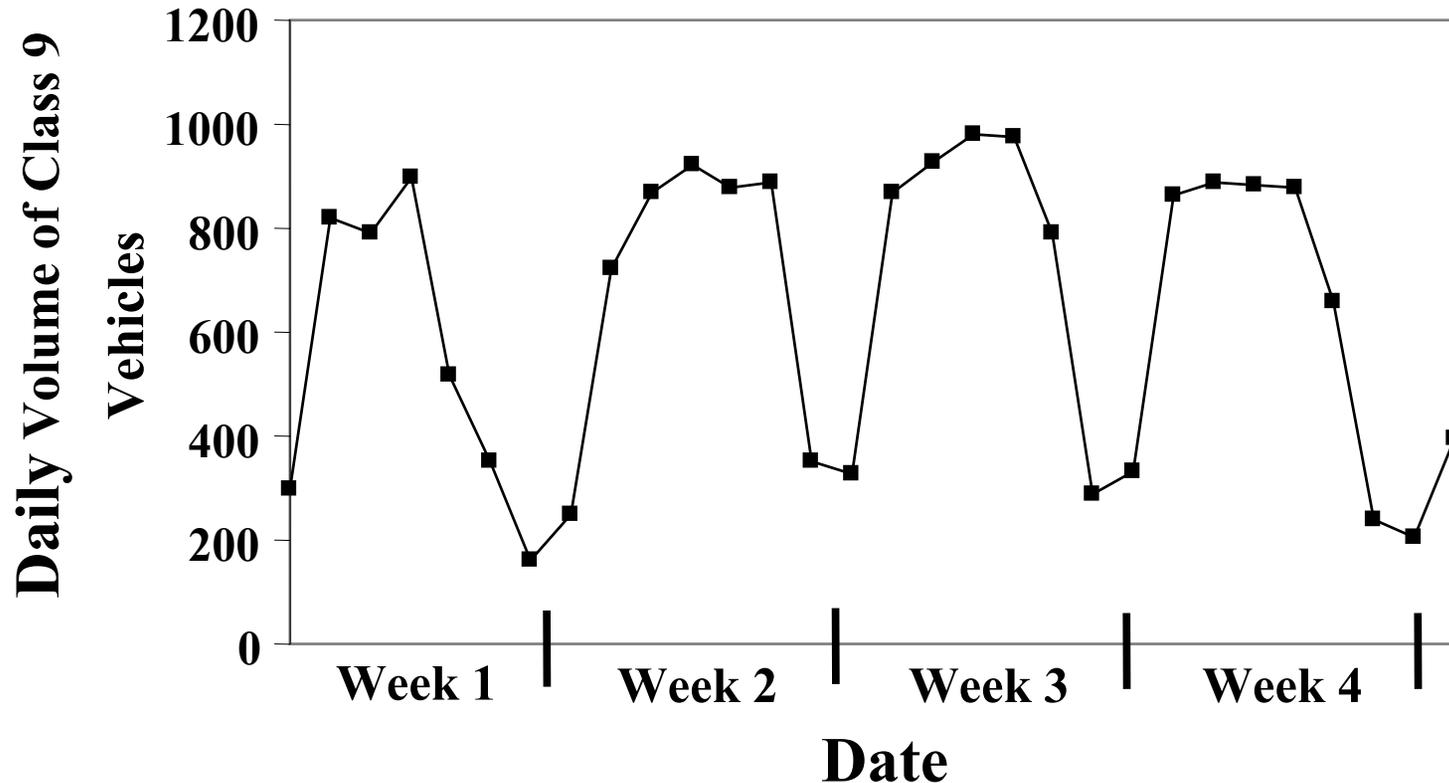
- Hourly
- Daily
- Monthly
- Annual

Variation in Hourly Truck Volumes



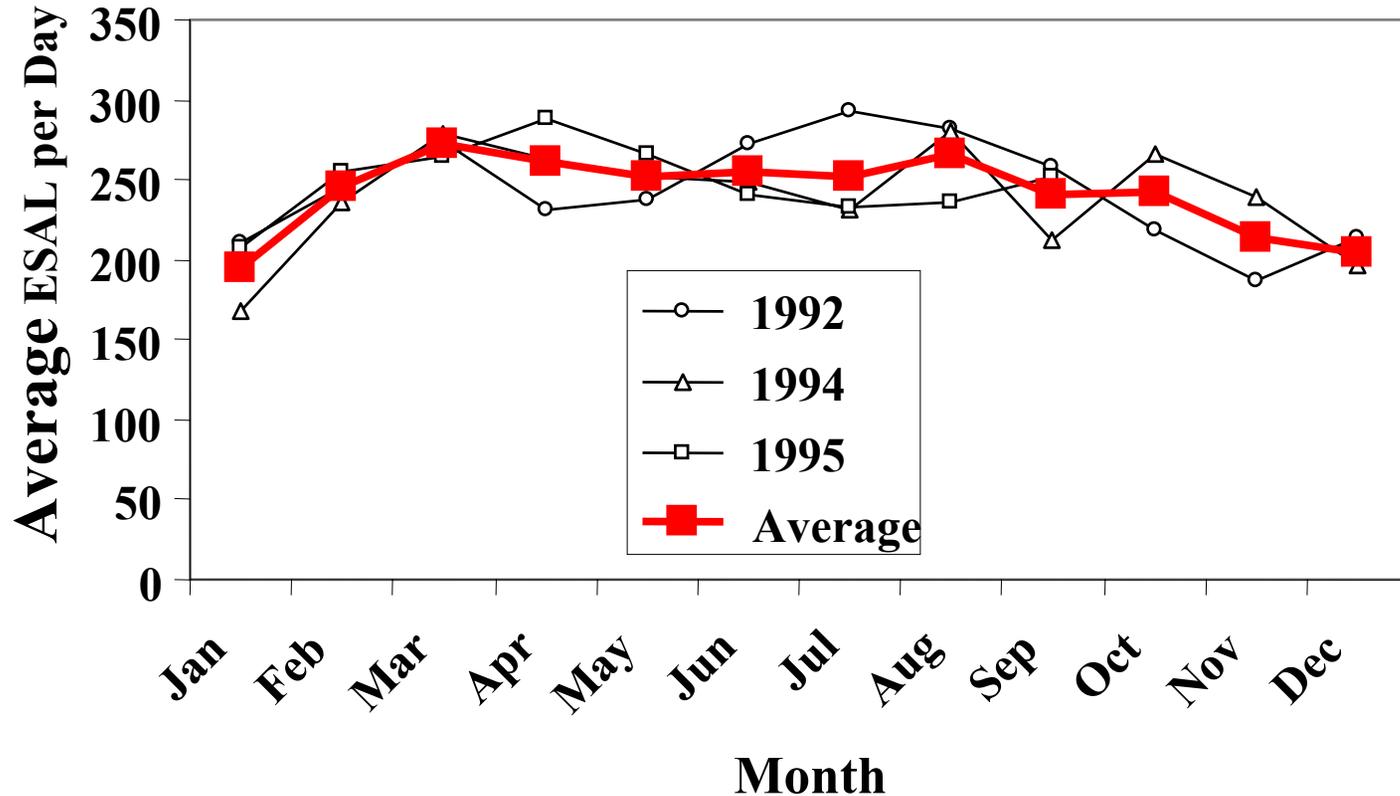
- Steady volumes between 9 and 16
- Low truck volumes at night

Variation in Daily Truck Volumes



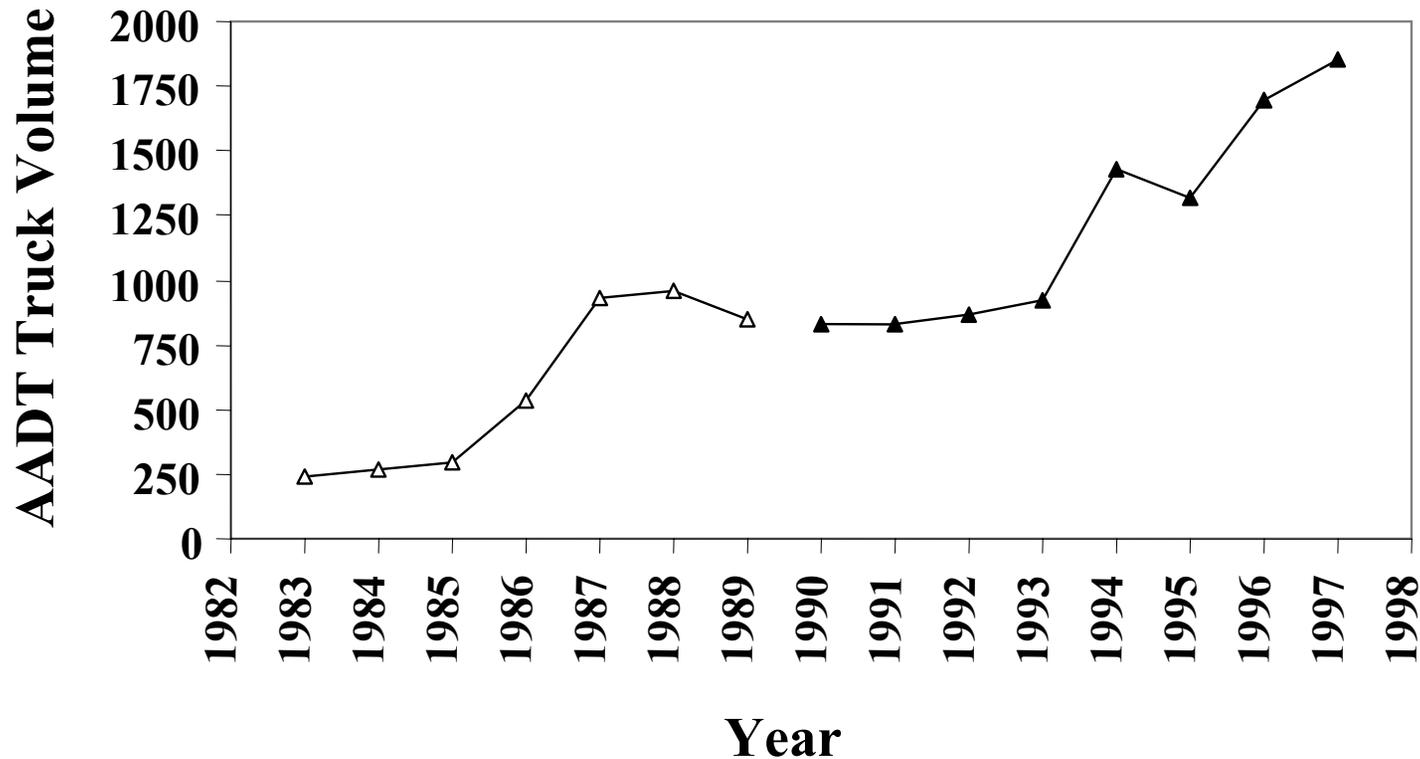
- Weekend volumes tend to be lower
- Daily volumes follow a pattern

Variation in Monthly Truck Volumes



- May exist, but difficult to establish
- Winter months are usually lowest

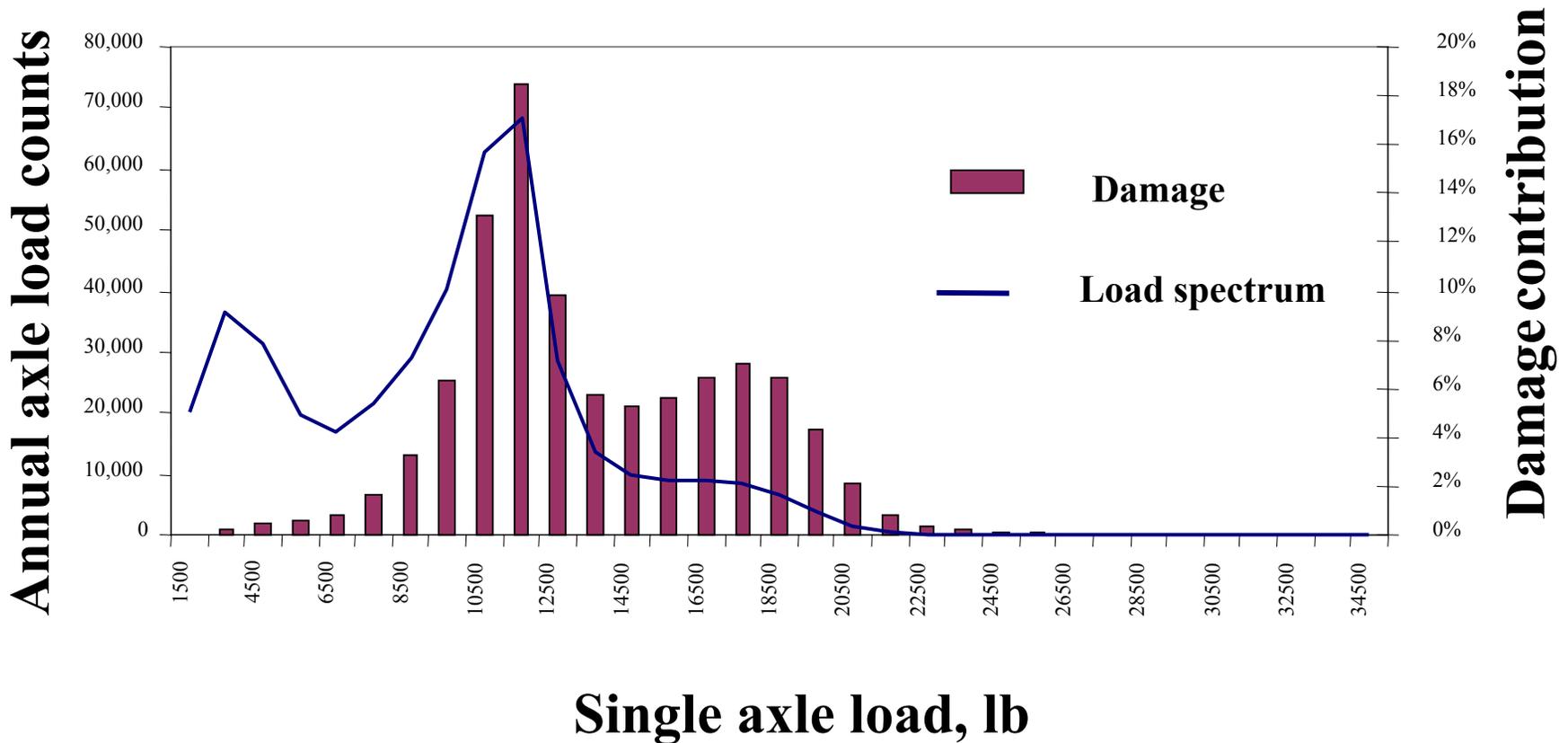
Variation in Annual Truck Volumes



- Annual volumes are typically increasing

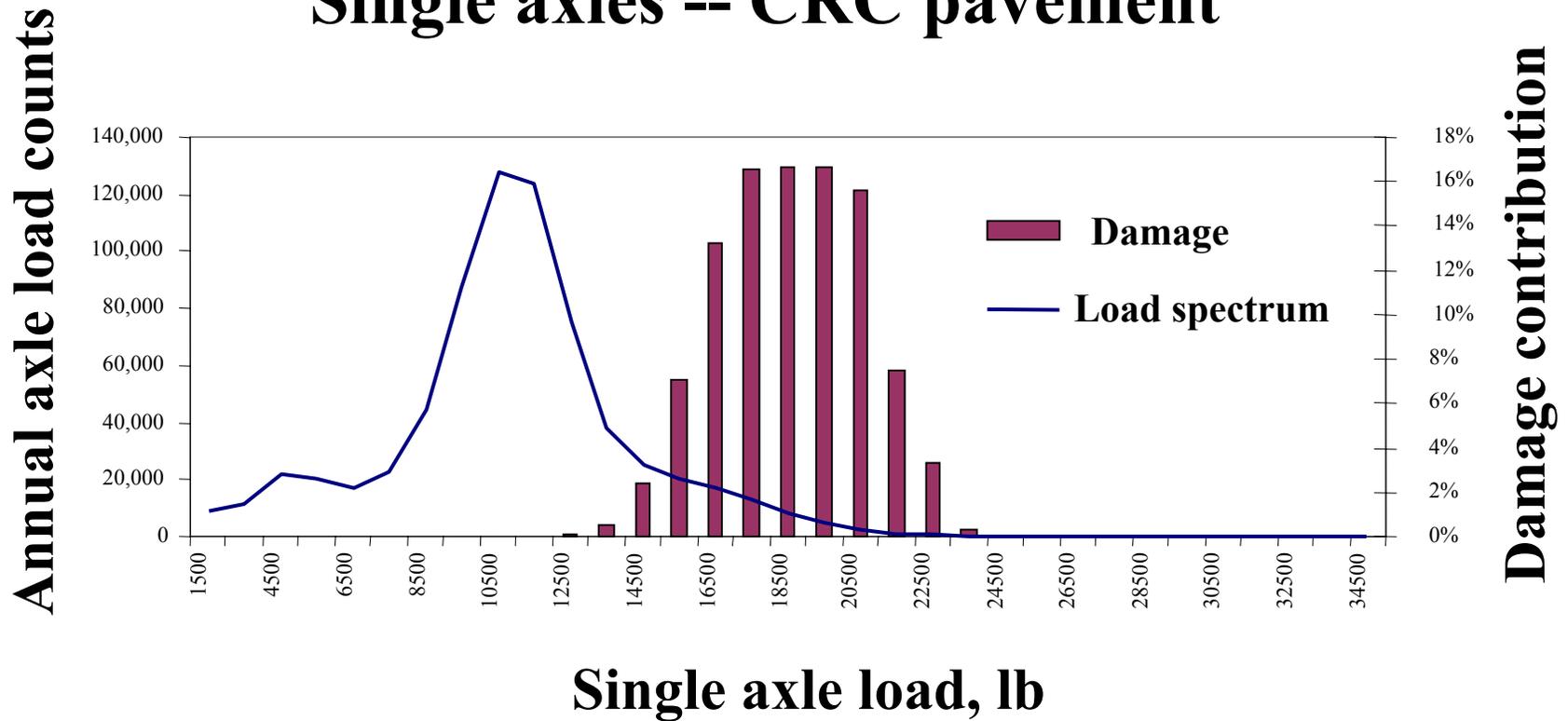
Effect of Heavy Loads

Single axles -- AC pavement



Effect of Heavy Loads

Single axles -- CRC pavement



Required Accuracy of WIM Systems

Variable	Estimated Error, %
Axle weight	$\pm 10 - 30$
Truck volumes	$\pm 10 - 40$
Lane distribution	$\pm 10 - 20$
Traffic growth	$\pm 10 - 30$
Truck suspension, tires, etc.	$\pm 10 - 20$

Summary

- Careful characterization of traffic loads is critical for improving reliability of pavement design
- New pavement design methods require axle load spectra
- Working with axle load spectra is challenging
 - Spectra consist of many values
 - The knowledge of characteristics of axle load spectra is dispersed
 - Graphical displays of axle load spectra help

Summary, Continued

- Most of the additional data required by mechanistic pavement design procedures can be obtained using existing WIM technology
- Some changes in WIM system calibration, data processing and storage will be required
- Greater attention should be paid to heavy loads
- Accuracy of traffic loads used for pavement design depends on many variables not just axle loads