Traffic and the 2002 Pavement Design Guide

by

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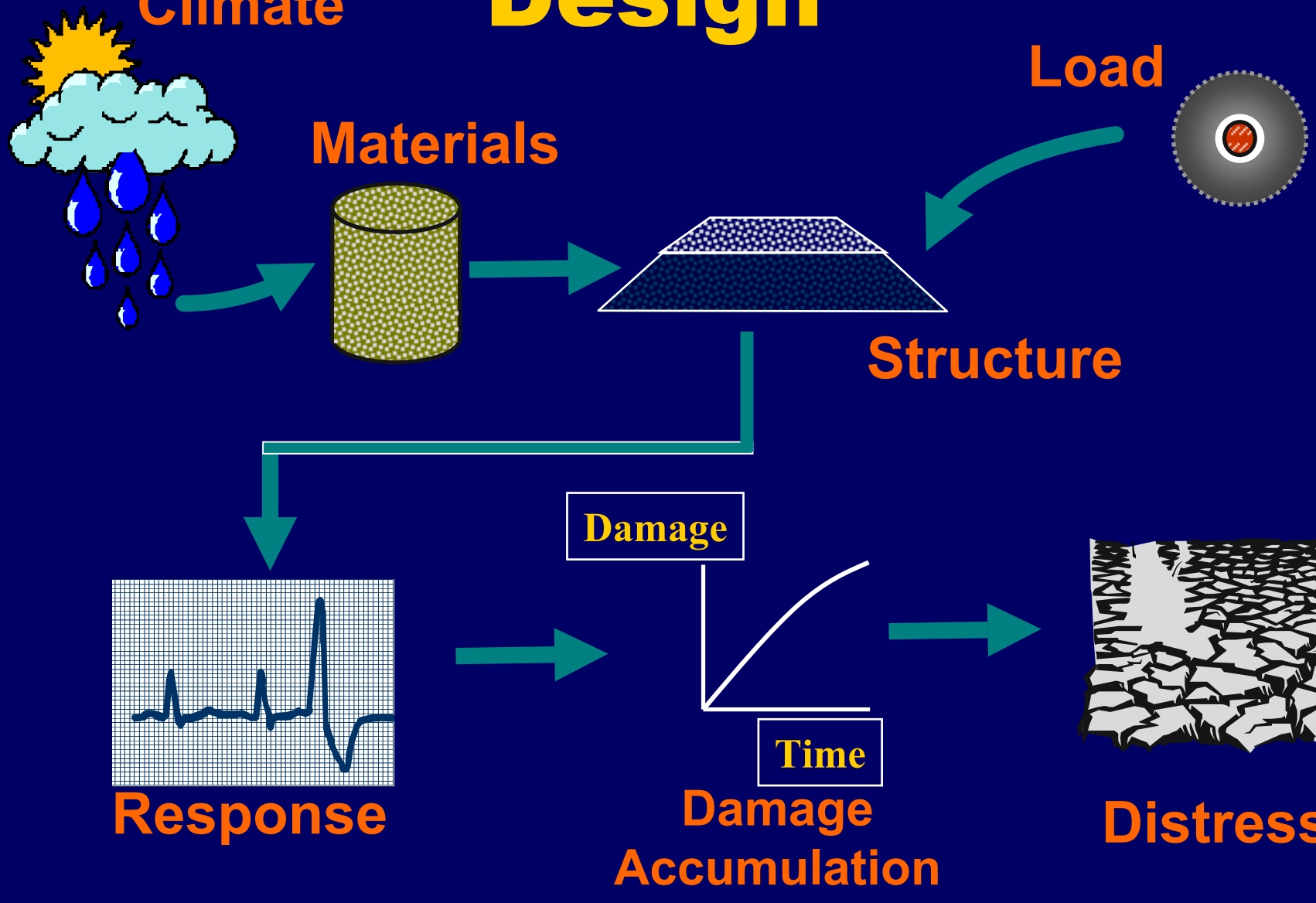
2002 Pavement Design Guide

- NCHRP 1-37A
- Final deliverables due April 2003
- Evaluation by DOTs
- Adoption as the AASHTO Design Guide

Mechanistic-Empirical Design



2002 Design Guide Traffic Inputs

No more ESALs!

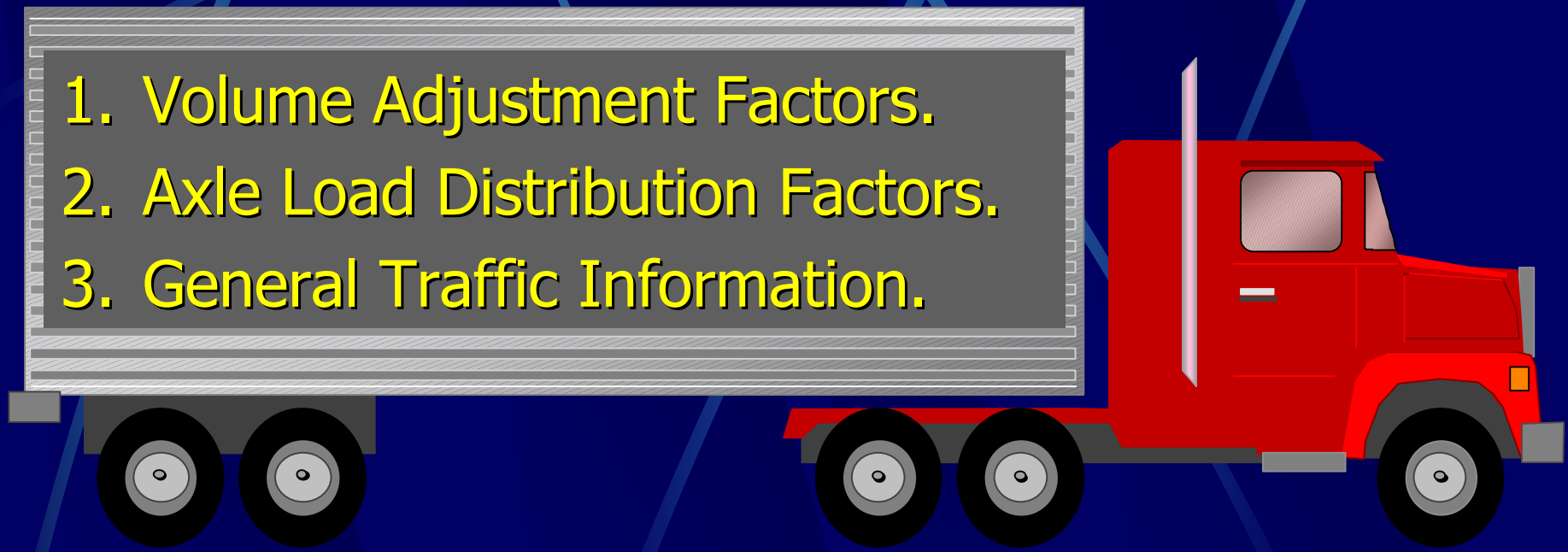
- Traffic input by
  - Vehicle type (number of axles)
  - Axle weight
- Quantity and quality of raw traffic data similar to that used to compute ESALs
  - Consistent w/ FHWA Traffic Monitoring Guide

Traffic Hierarchical Input Levels:

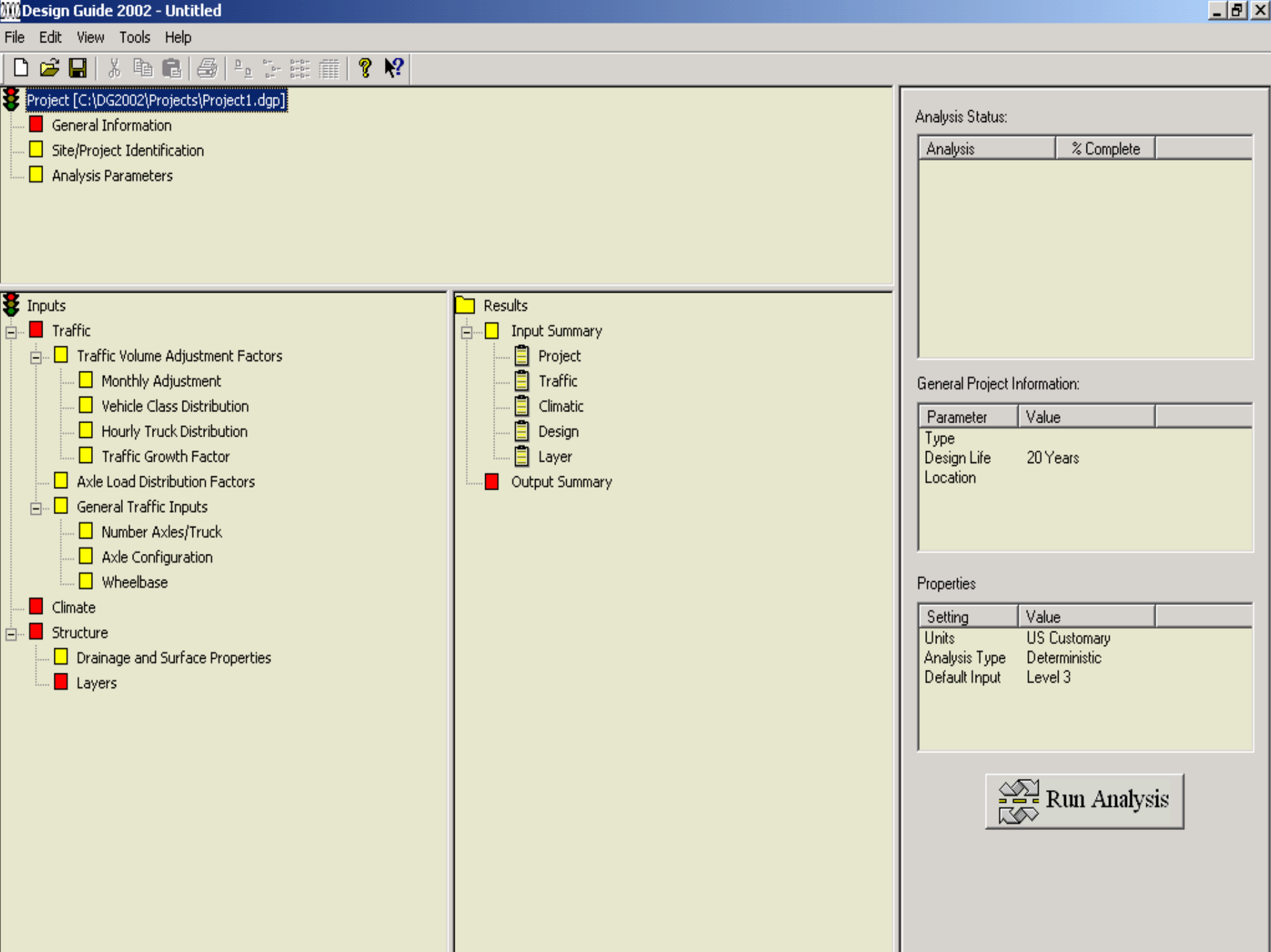
Input Level	Input Values	Knowledge of Parameters
1	Segment Specific AVC & WIM Measurements	Good
2a	Segment Specific AVC & Regional WIM Measurements	Fair
2b	Regional AVC & WIM Measurements	Fair
3	Site Specific Vehicle Count Data w/Defaults – Educated Guess	Poor

Traffic Module – Input Categories

1. Volume Adjustment Factors.
2. Axle Load Distribution Factors.
3. General Traffic Information.



What traffic inputs are needed for design?


Design Guide 2002 - Untitled
File Edit View Tools Help
Project [C:\DG2002\Projects\Project1.dgp]
General Information
Site/Project Identification
Analysis Parameters
Inputs
Traffic
Traffic Volume Adjustment Factors
Monthly Adjustment
Vehicle Class Distribution
Hourly Truck Distribution
Traffic Growth Factor
Axle Load Distribution Factors
General Traffic Inputs
Number Axles/Truck
Axle Configuration
Wheelbase
Climate
Structure
Drainage and Surface Properties
Layers
Results
Input Summary
Project
Traffic
Climatic
Design
Layer
Output Summary
Analysis Status:
Analysis
% Complete
General Project Information:
Parameter
Value
Type
Design Life
20 Years
Location
Properties
Setting
Value
Units
US Customary
Analysis Type
Deterministic
Default Input
Level 3
Run Analysis

AADTT: Average Annual Daily Truck Traffic

- Definition:
  - The average daily number of trucks (vehicle classes 4-13) expected over the base year.
- Calculated:
  - From AVC/WIM data or trip generation studies.
  - By averaging the number of trucks measured over multiple 24-hour periods of time in each season/month & weighted between weekends & weekdays.

Input Level	1	2	3
	√	√	

AADT: Average Annual Daily Traffic

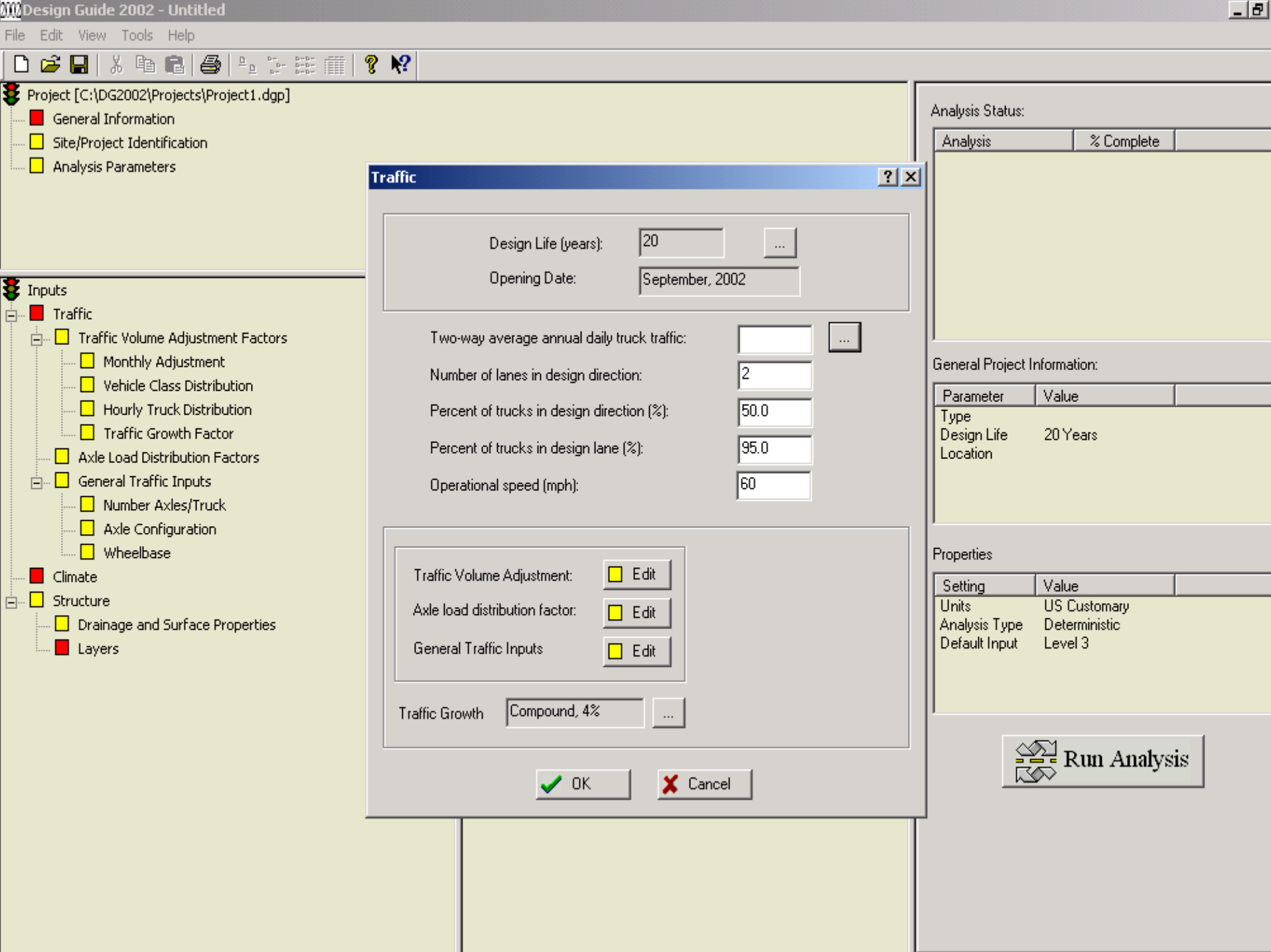
- Definition:
  - The average daily number of vehicles (vehicle classes 1-13) expected over the base year.
- Calculated:
  - From vehicle count data or trip generation studies.
  - By averaging the number of vehicles measured over multiple periods of time in each season/month & weighted between weekends & weekdays.

Input Level	1	2	3
			√

Percent Trucks

- Definition:
  - The percent of trucks (vehicle classes 4-13) in the traffic stream that are expected over the base year.
- Calculated:
  - From vehicle count data or trip generation studies.
  - By dividing the number of trucks by the total number of vehicles on a day & averaged for each season/month & weighted between weekends & weekdays.

Input Level	1	2	3
			√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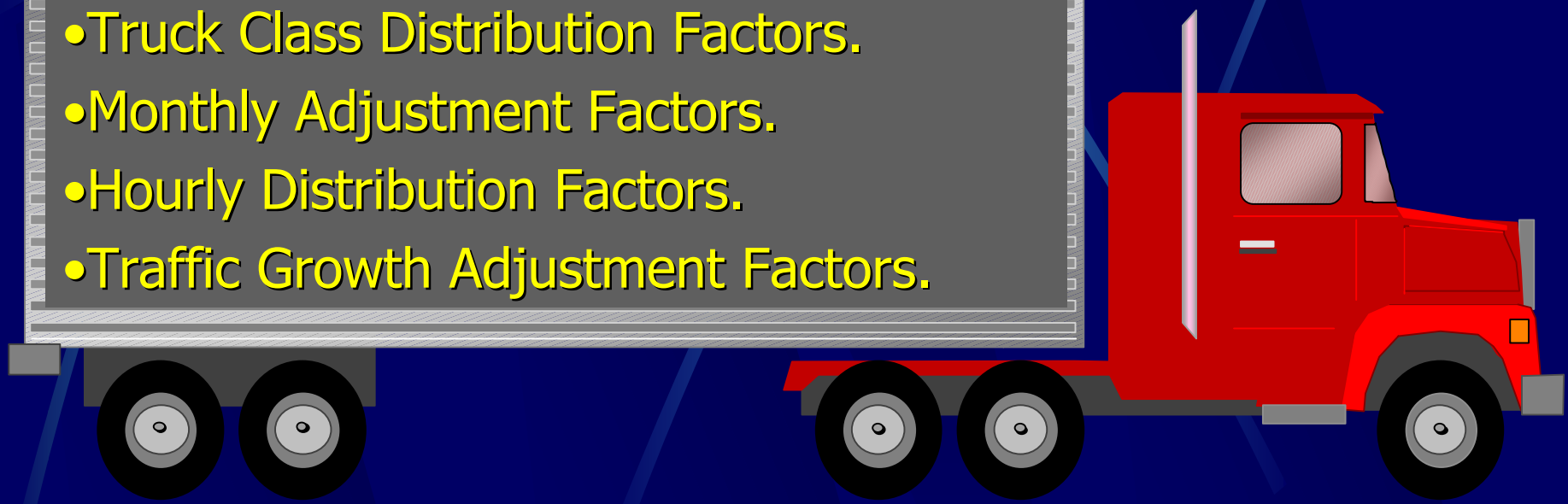
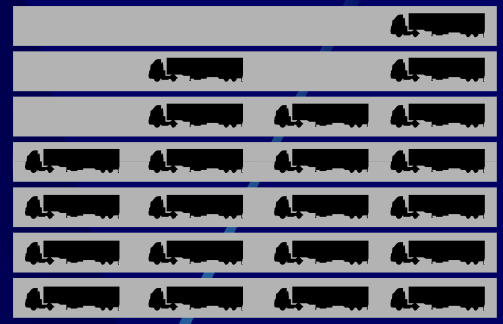
Traffic Growth Factor
Axle Load Distribution Factors
General Traffic Inputs
Number Axles/Truck
Axle Configuration
Wheelbase
Climate
Structure
Drainage and Surface Properties
Layers
Traffic
Design Life (years): 20
Opening Date: September, 2002
Two-way average annual daily truck traffic:
Number of lanes in design direction: 2
Percent of trucks in design direction (%): 50.0
Percent of trucks in design lane (%): 95.0
Operational speed (mph): 60
Traffic Volume Adjustment: Edit
Axle load distribution factor: Edit
General Traffic Inputs Edit
Traffic Growth Compound, 4%
OK
Cancel
Analysis Status:
Analysis
% Complete
General Project Information:
Parameter
Value
Type
Design Life 20 Years
Location
Properties
Setting
Value
Units US Customary
Analysis Type Deterministic
Default Input Level 3
Run Analysis

Truck Traffic Volume Adjustment Factors

- Truck Class Distribution Factors.
- Monthly Adjustment Factors.
- Hourly Distribution Factors.
- Traffic Growth Adjustment Factors.



Truck Distribution Factors



- Definition:
  - The normalized distribution of truck types expected over the base year.
- Calculated:
  - From AVC/WIM data or trip generation studies.
  - By dividing the number of trucks in a class by the total number of trucks on an average day in the base year.

Input Level	1	2	3
	√	√	

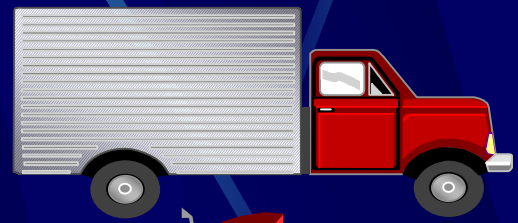
Truck Traffic Classification Factor

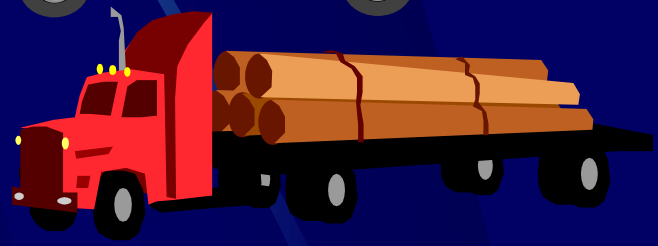
- Definition:
  - A factor that is used to group or classify roadways with similar truck traffic compositions and loading characteristics.
  - 17 Groups defined from LTPP data.
- Defined by functional classification & vehicle count data or trip generation studies.

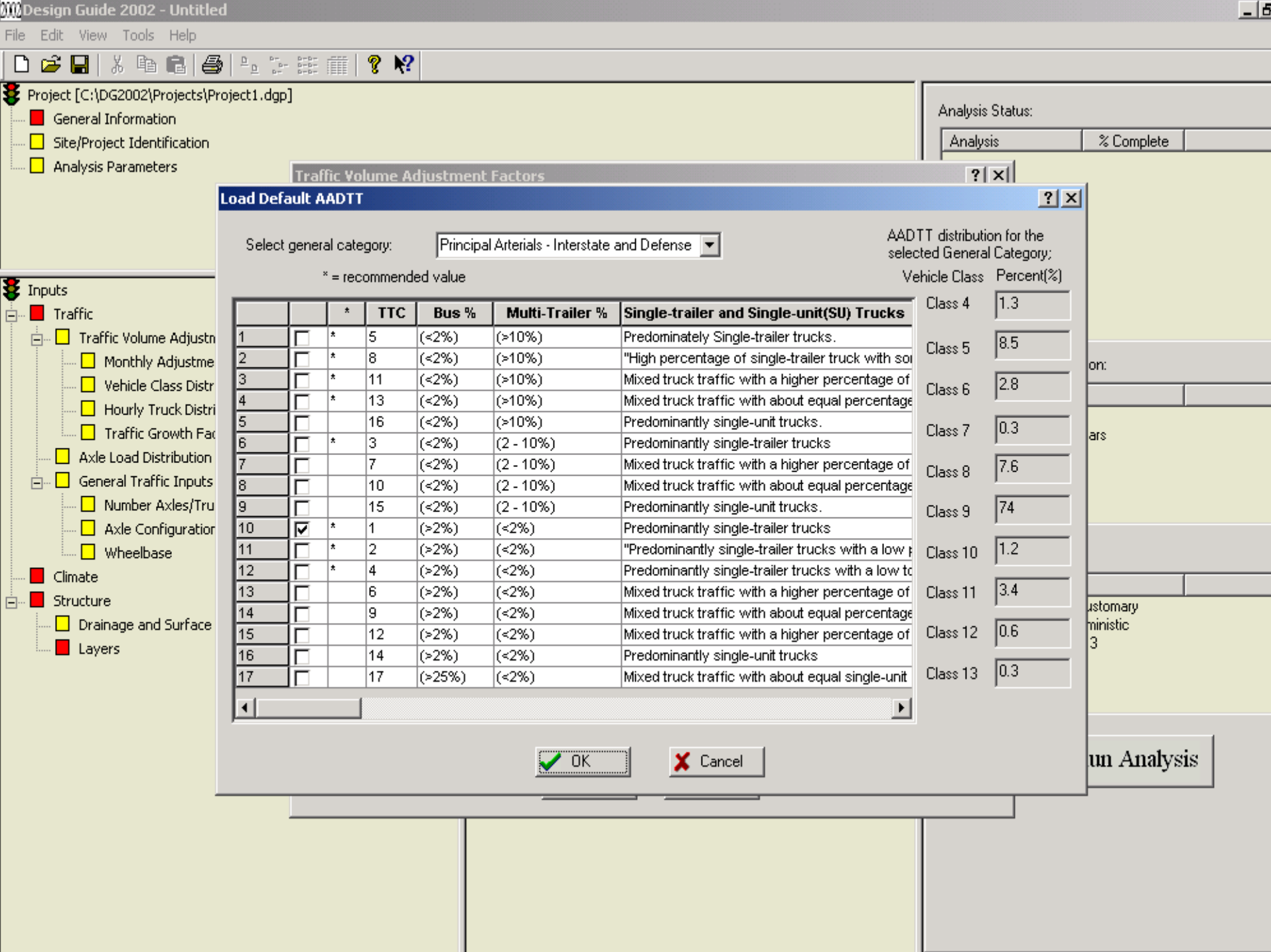
Input Level	1	2	3
			√

Truck Traffic Classification Group in the Same Functional Class Defined by:

- Percentage of buses
- Percentage of single unit trucks
- Percentage of single-trailer trucks
- Percentage of multi-trailer trucks







		*	TTC	Bus %	Multi-Trailer %	Single-trailer and Single-unit(SU) Trucks
1	☐	*	5	(<2%)	(>10%)	Predominately Single-trailer trucks.
2	☐	*	8	(<2%)	(>10%)	"High percentage of single-trailer truck with sor
3	☐	*	11	(<2%)	(>10%)	Mixed truck traffic with a higher percentage of
4	☐	*	13	(<2%)	(>10%)	Mixed truck traffic with about equal percentage
5	☐		16	(<2%)	(>10%)	Predominantly single-unit trucks.
6	☐	*	3	(<2%)	(2 - 10%)	Predominantly single-trailer trucks
7	☐		7	(<2%)	(2 - 10%)	Mixed truck traffic with a higher percentage of
8	☐		10	(<2%)	(2 - 10%)	Mixed truck traffic with about equal percentage
9	☐		15	(<2%)	(2 - 10%)	Predominantly single-unit trucks.
10	☑	*	1	(>2%)	(<2%)	Predominantly single-trailer trucks
11	☐	*	2	(>2%)	(<2%)	"Predominantly single-trailer trucks with a low p
12	☐	*	4	(>2%)	(<2%)	Predominantly single-trailer trucks with a low to
13	☐		6	(>2%)	(<2%)	Mixed truck traffic with a higher percentage of
14	☐		9	(>2%)	(<2%)	Mixed truck traffic with about equal percentage
15	☐		12	(>2%)	(<2%)	Mixed truck traffic with a higher percentage of
16	☐		14	(>2%)	(<2%)	Predominantly single-unit trucks
17	☐		17	(>25%)	(<2%)	Mixed truck traffic with about equal single-unit

Monthly Distribution Factors

- Definition:
  - A ratio to adjust the average annual daily truck traffic into monthly truck traffic.
- Assumption:
  - The monthly distribution factors are constant over time.
- Default values for each month = 1.0.

Input Level	1	2	3
	√	√	√

Hourly Distribution Factors

- Definition:
  - The percentage of the average annual daily truck traffic (AADTT) within each hour of the day.
- Assumption:
  - The hourly distribution factors are constant over time and between truck classes.

Input Level	1	2	3
	√	√	√

Time of Day or Hourly Distribution Default Values:

Time of Day Interval	% Daily Truck Traffic	Hourly Distribution Factor
Midnight to 6 AM	13.8	0.023
6 AM to 10 AM	20.0	0.050
10 AM to 4 PM	35.4	0.059
4 PM to 8 PM	18.4	0.046
8 PM to Midnight	12.4	0.031

Truck Traffic Growth Over the Design Period

- Alternate Functions for Increases in Truck Volume:
  - No Growth
  - Linear
  - Compound
- Growth Considered for each Truck Class Separately.
- Opening Date = The date that the roadway is opened to traffic, excluding construction traffic.

Directional Distribution Factors

- Definition:
  - The percentage of the average annual daily truck traffic in one direction along the roadway.
- Calculated:
  - From AVC or traffic count data measured over time.
  - By dividing the average annual daily truck traffic in one direction by the AADTT for a particular year.

Input Level	1	2	3
	√	√	√

Directional Distribution Factors

- Assumption:
  - Directional distribution factors are constant with time and for all truck classes.
- Defined for the predominant type of truck.
- Defaults for specific truck classes:

Truck Class		Directional Factor
4	Buses	0.50
5-7	Single Unit Trucks	0.62
8-10	Single-Trailer Trucks	0.55
11-13	Multi-Trailer Trucks	0.50

Lane Distribution Factors

- Definition:
  - The percentage of the average annual daily truck traffic in one lane along the roadway.
- Calculated:
  - From AVC or traffic count data measured over time.
  - By dividing the average annual daily truck traffic in one lane by the AADTT in one direction for a particular year.

Input Level	1	2	3
	√	√	√

Lane Distribution Factors

- Assumption:
  - Lane distribution factors are constant with time and for all truck classes.
- Defined for the predominant type of truck.
- Defaults for multi-lane roadways:

Total Number of Lanes, Both Directions	Lane Distribution Factor
2	1.0
4	0.9
6	0.6
6+	0.5

Axle Load Distribution Factors

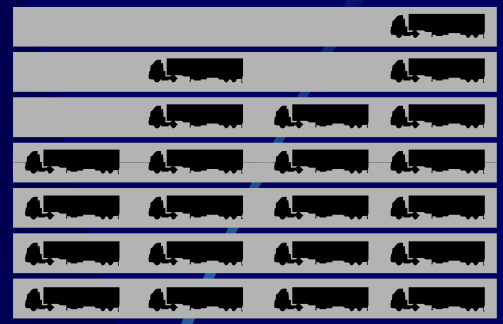
Truck Class and Load Group Dependent

Axle Load Distribution

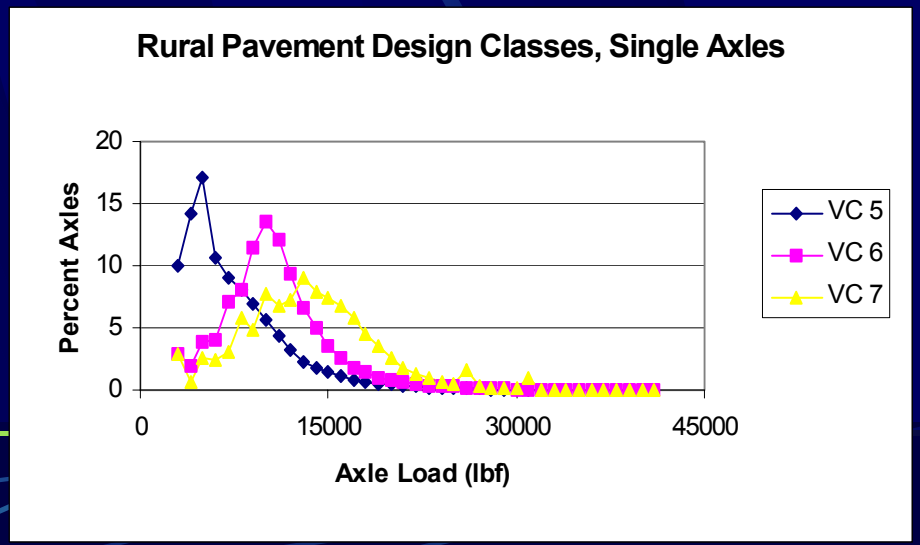
- Definition:
  - The number of axles in each load interval by axle type for a specific truck class.
- Calculated:
  - From WIM data.
  - By averaging the daily number of axles measured within each load interval of an axle type for a truck class divided by the total number of axles for all load intervals.

Input Level	1	2	3
	√	√	

Axle Load Distribution

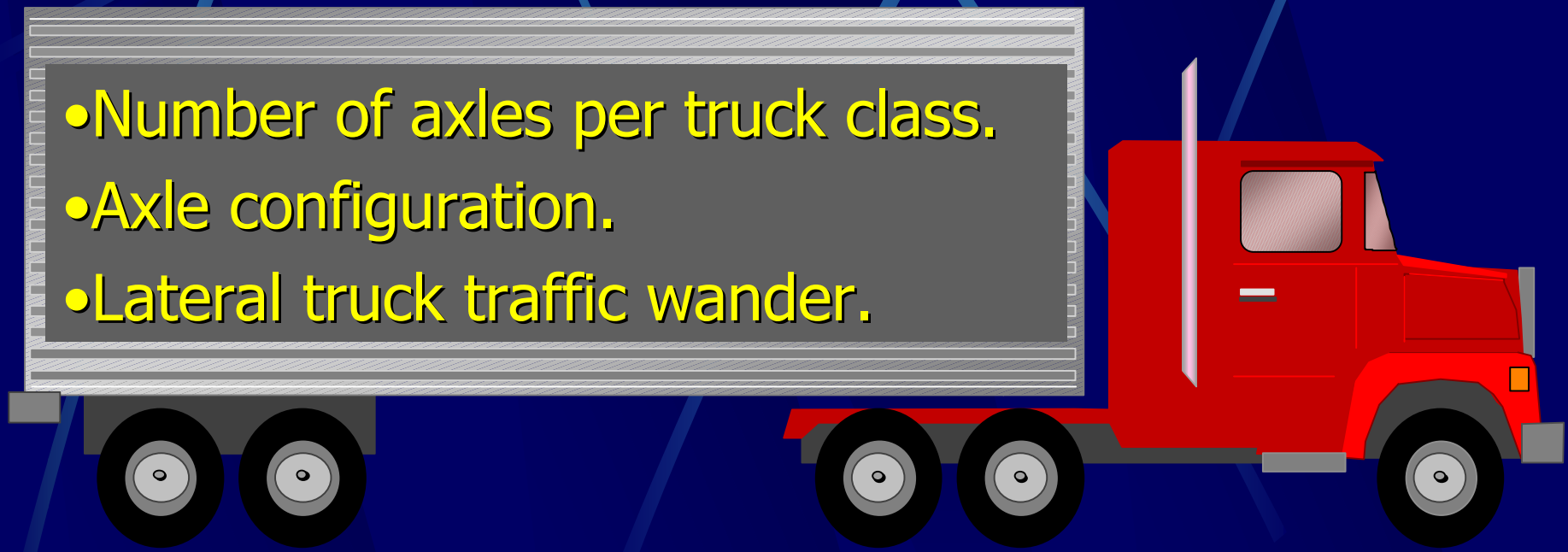


- Defaults:
  - Normalized distributions for Level 3 defined from LTPP data.
  - Factors dependent on the Truck Traffic Classification Group.

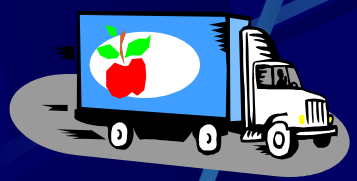


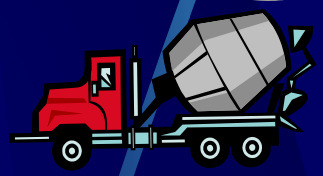
General Truck Traffic Information

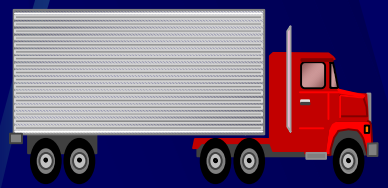
- Number of axles per truck class.
- Axle configuration.
- Lateral truck traffic wander.

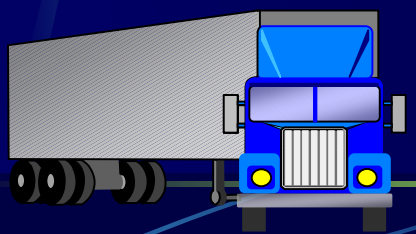


Number of Axles per Axle Type Per Truck Class









- Definition:
  - The average number of axles for each axle type within each truck class.
- Calculated:
  - From WIM data measured over time.
  - By dividing the total number of a specific axle type measured for a truck class by the total number of trucks in that class.

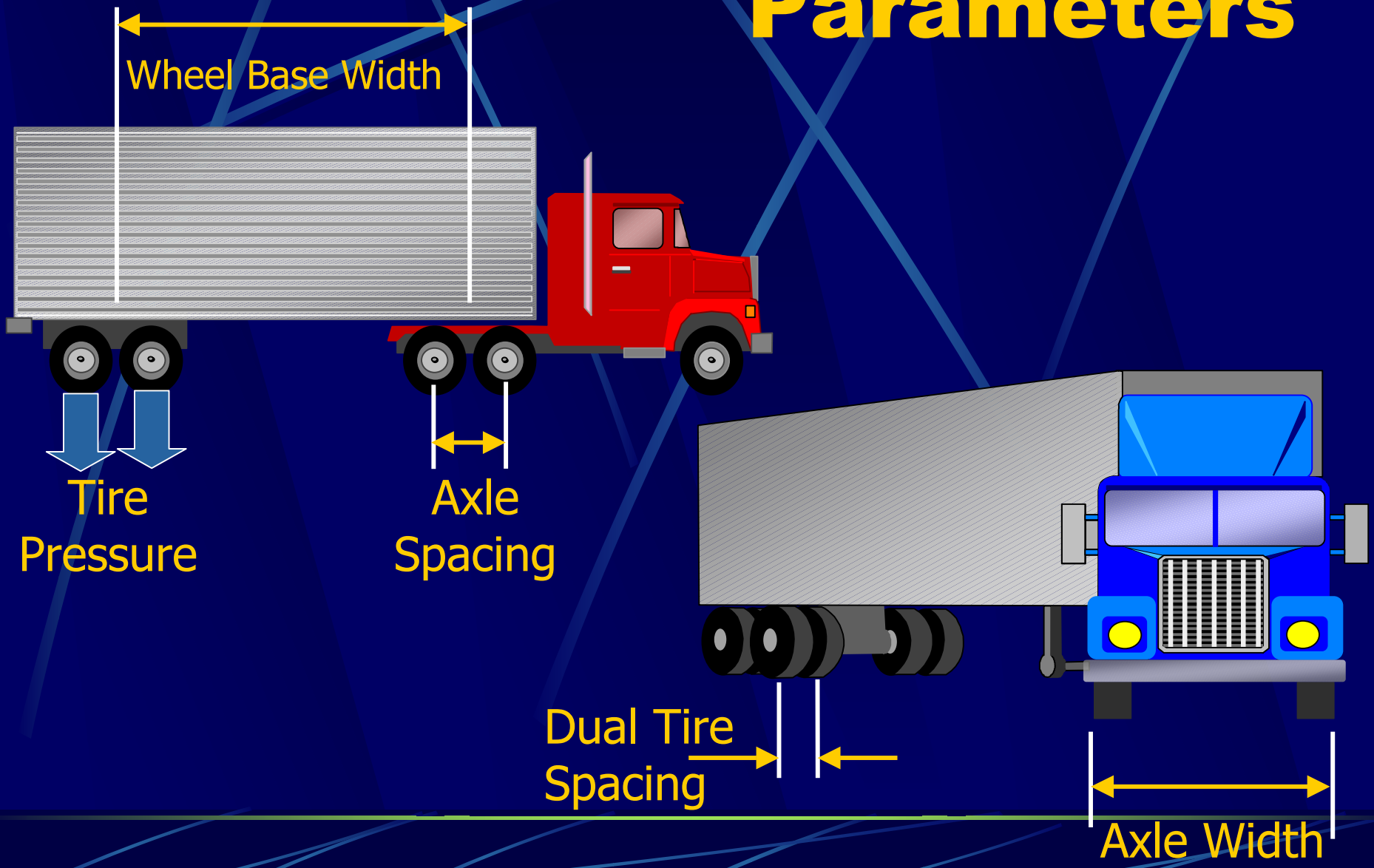
Input Level	1	2	3
	√	√	

Number of Axles per Axle Type Per Truck Class

- Assumption:
  - The number of axles for each axle type are constant with time.
- Default Values for Level 3 Defined from LTPP Data.

Truck Class	Single Axles	Tandem Axles	Tridem Axles
4	1.62	0.39	0.00
5	2.00	0.00	0.00
6	1.02	0.99	0.00
7	1.00	0.26	0.83
8	2.38	0.67	0.00
9	1.13	1.93	0.00
10	1.19	1.09	0.89
11	4.29	0.26	0.06
12	3.52	1.14	0.06
13	2.15	2.13	0.35

Axle Configuration Parameters

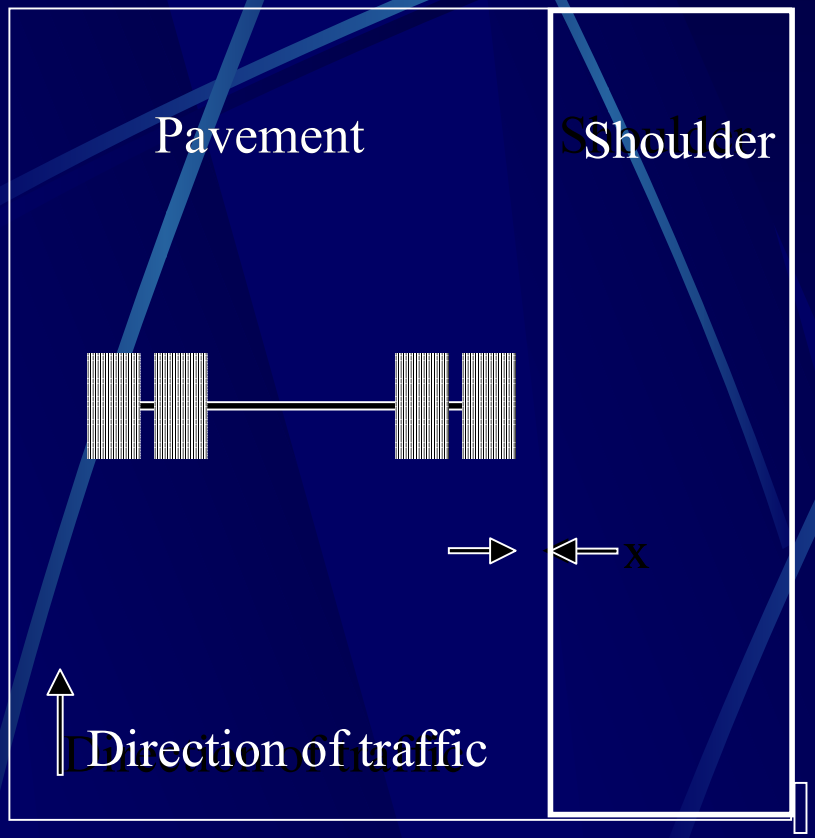


Tire Pressure

- Definition:
  - The hot inflation pressure of the tire.
    - 10 % above cold inflation pressure
  - It is assumed that the hot inflation pressure equals the contact pressure.
  - Default Values
    - Single = 120 psi
    - Dual = 110 psi

Input Level	1	2	3
	√	√	√

Traffic Wander



Used to calculate pavement responses & the number of axle load applications over a point for predicting distress & performance.

- Mean wheel location = 18 in.
- Standard deviation = 10 in.
- Design lane width.

Traffic Module Inputs - Summary

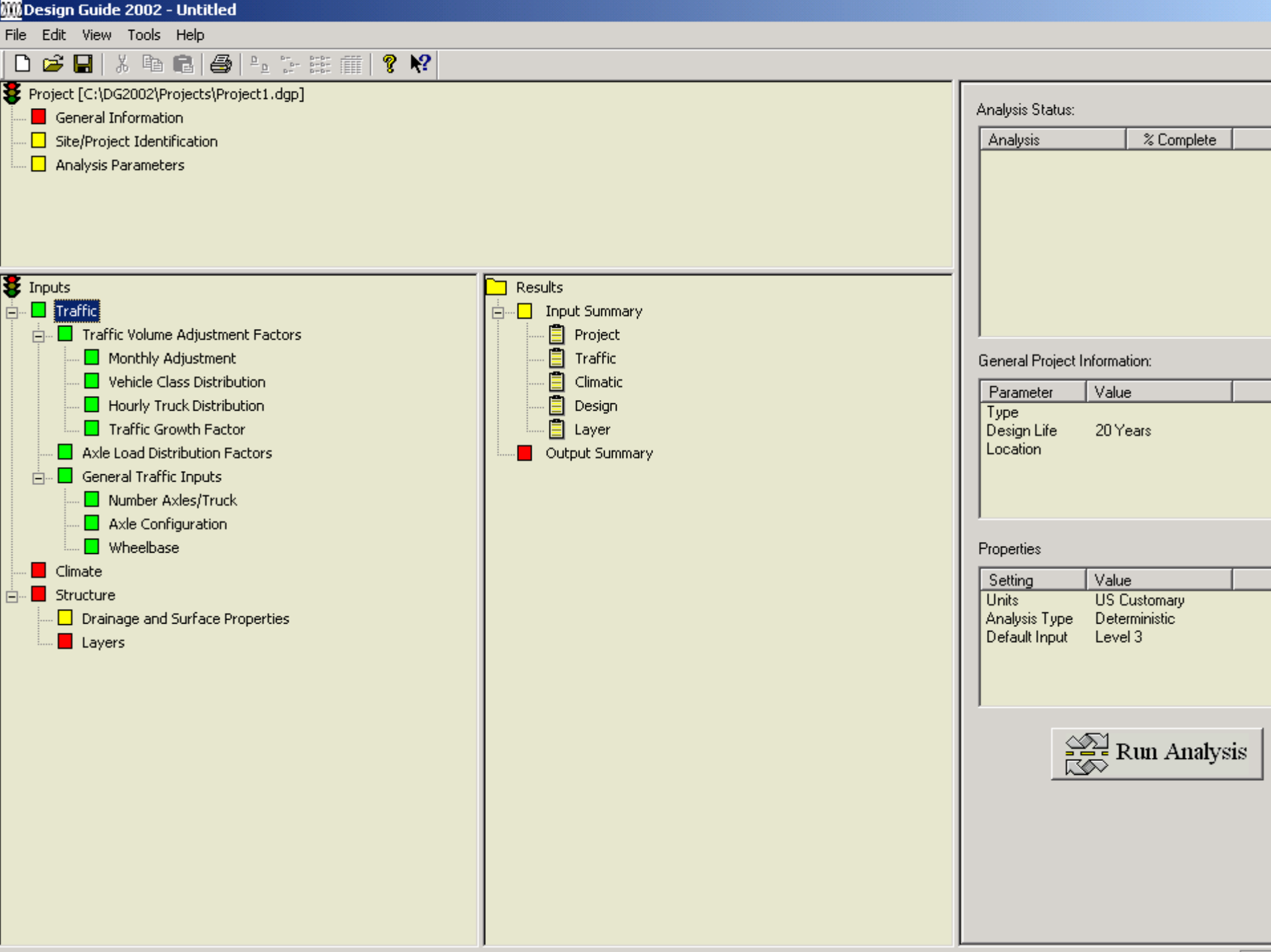
Input Parameters	Input Level			
	1	2a	2b	3
AADTT for Base Year	√	√	√	
Truck Distribution Factors for Base Year	√	√	√	
Axle Load Distribution by Truck & Axle Type	√	√	√	
Monthly Distribution Factors	√	√	√	√
Hourly Distribution Factors	√	√	√	√

Traffic Module Inputs - Summary

Input Parameters	Input Level			
	1	2a	2b	3
AADT for Base Year				√
Percent Trucks for Base Year				√
Truck Traffic Classification Factor				√
Directional Distribution Factor	√	√	√	√
Lane Distribution Factor	√	√	√	√
Truck Traffic Growth Function/Factor	√	√	√	√

Traffic Module Inputs - Summary

Input Parameters	Input Level			
	1	2a	2b	3
No. of Axle Types per Truck Class	√	√	√	
Axle Spacing	√	√	√	
Axle Load Groups	√	√	√	√
Tire Spacing/Axle Configuration	√	√	√	√
Tire Pressure	√	√	√	√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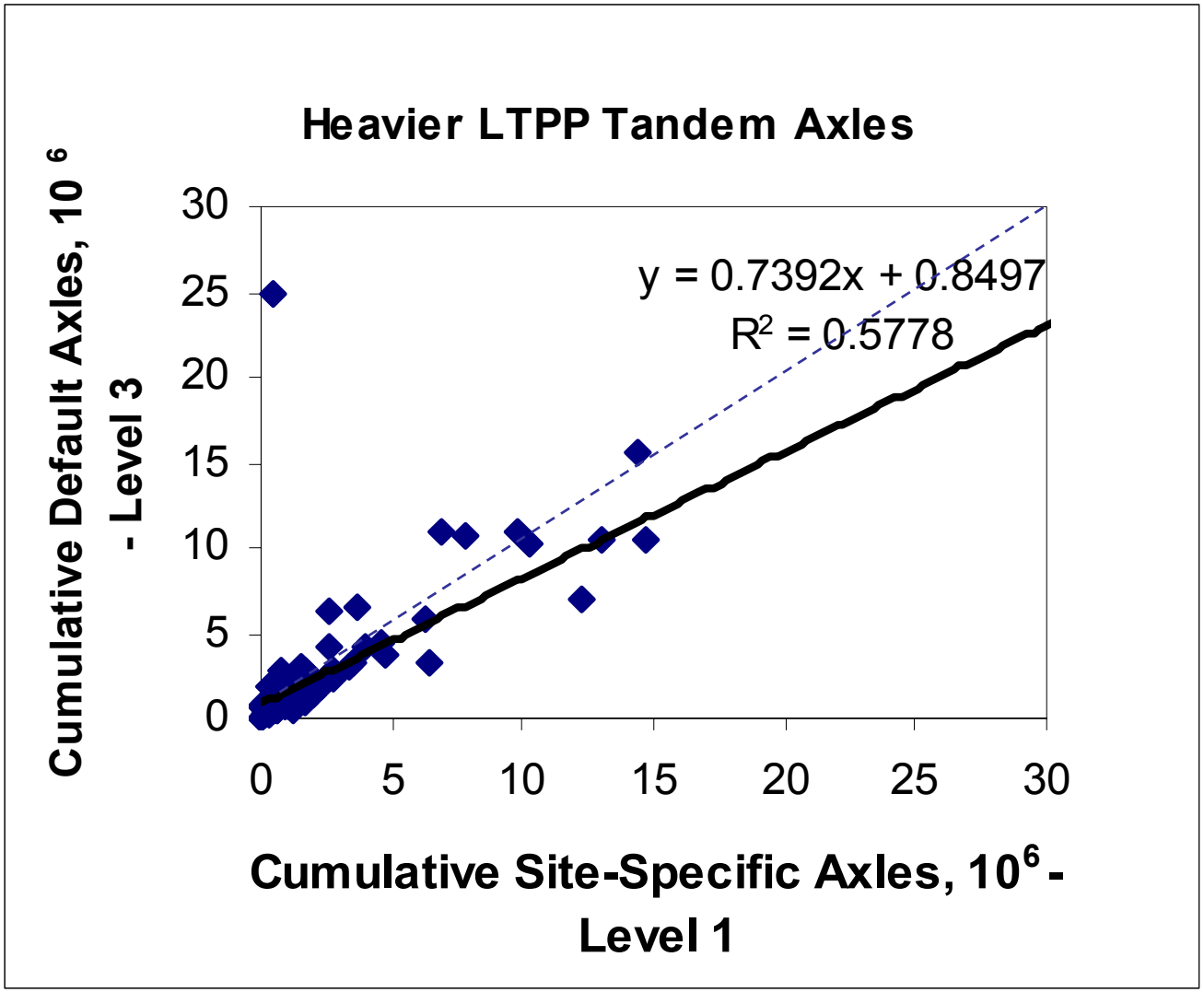
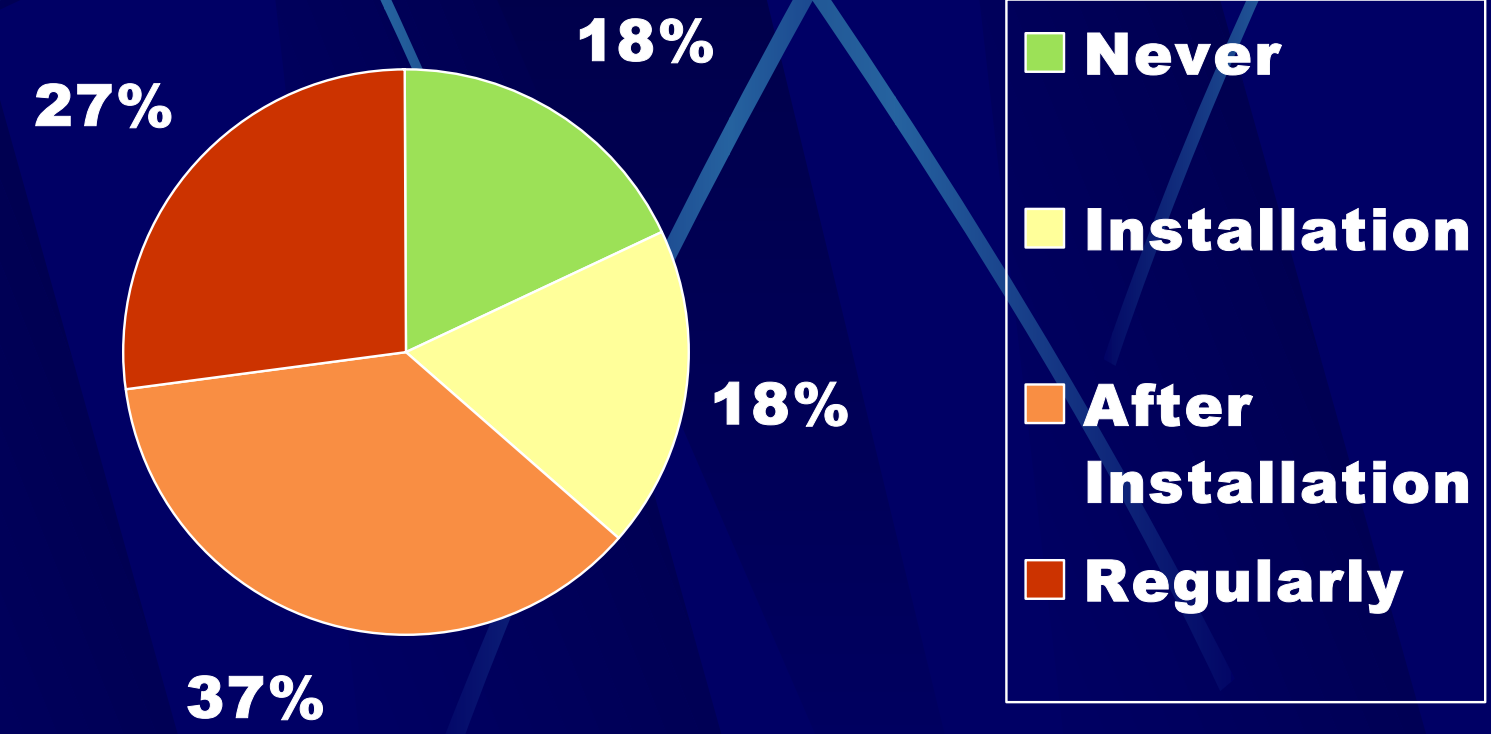
Traffic Module Output Files

Year	Month	Hour	Axle Type	Load Group				
				0-2	2-4	4-6	…..	x-y
k	j	l	Single					
			Tandem					
			Tridem					
			Quad					

Comparison of Level 1 and Level 3 LTPP Data

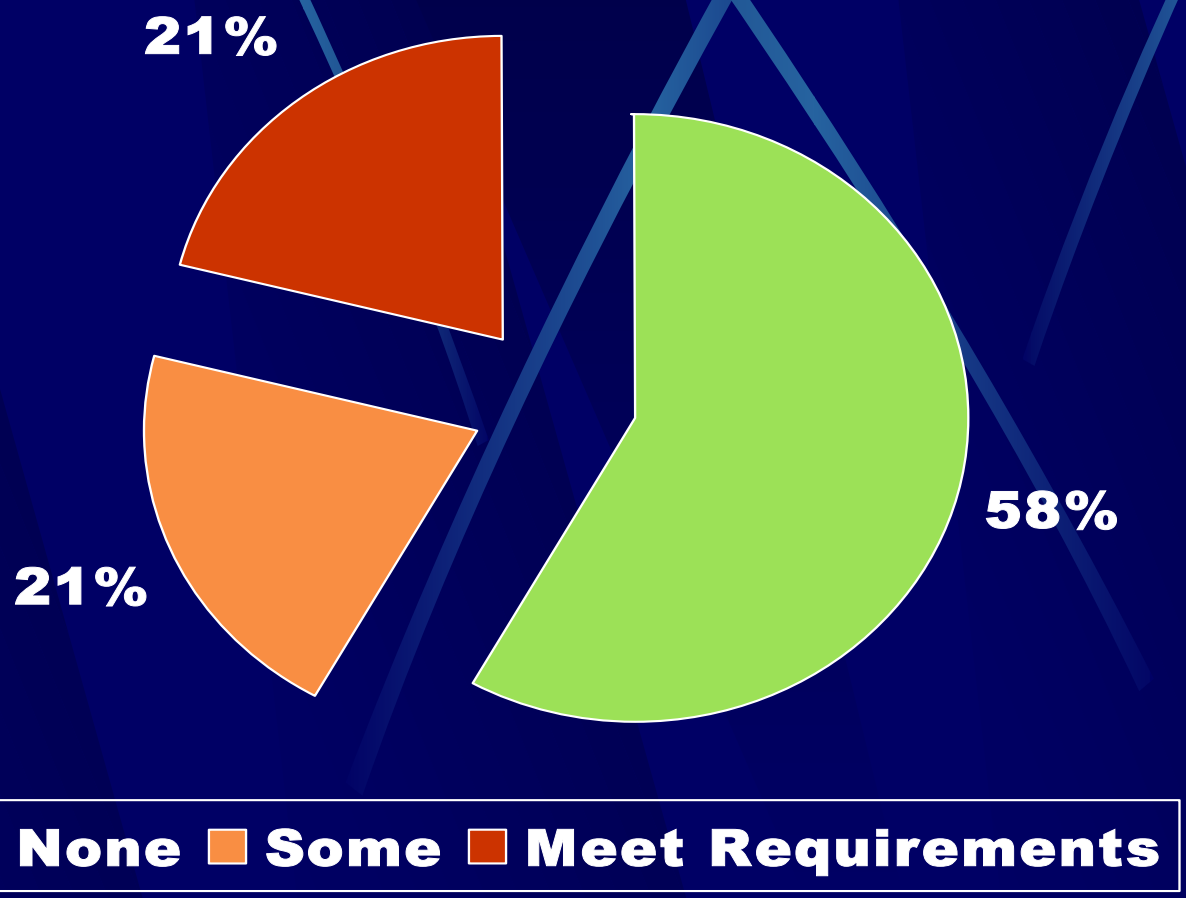


Quality of LTPP Traffic Data Calibration SPS 5 & 6



Passing LTPP Quality Control Checks

SPS Traffic Data in a Typical Year



2002 Pavement Design Guide Traffic Module Summary

- Extensive computations within traffic module for incremental damage accumulation.
- Module is flexible allowing user to use other default values.
- Default values based on LTPP data collected over time.
- Level 1 data is more reliable than Level 3.

Website: www.2002designguide.com