



# *ESAL*

## Equivalent Single Axle Load

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We all have a stake in **A**  **B**



# ESAL

## OUTLINE:

- ▶ What is ESAL?
- ▶ What is Design ESAL?
- ▶ BESAL vs CESAL
- ▶ SALT ESAL Calculator



# What is ESAL?

- ▶ Equivalent Single Axle Load.
- ▶ Concept developed out of the American Association of State Highway Officials (AASHO) Road Test (early 1960's).
- ▶ Establishes a pavement damage relationship for axles carrying different loads.



# An ESAL is:

An 18,000  
pound load on  
a single axle  
with dual tires.



(bing.com)



# AASHO Road Test

- ▶ Conducted in Ottawa, Illinois in 1956–1961.
- ▶ Studied performance of pavement structures (HMA & PCC) of known thickness under moving loads of known magnitude and frequency.
- ▶ Crucial in advancing knowledge of:
  - pavement structural design
  - pavement performance
  - load equivalencies
  - climate effects
- ▶ Detailed information at:
  - <http://www.pavementinteractive.org/article/aasho-road-test/>



# What is Design ESAL

- ▶ Design ESALs is a cumulative traffic load summary statistic.
- ▶ It represents a mix of traffic having different axle loads and configurations predicted over the design life or analysis period of a pavement.



# What is Design ESAL

When evaluating and designing pavement structures, the wheel load itself is not the primary concern.

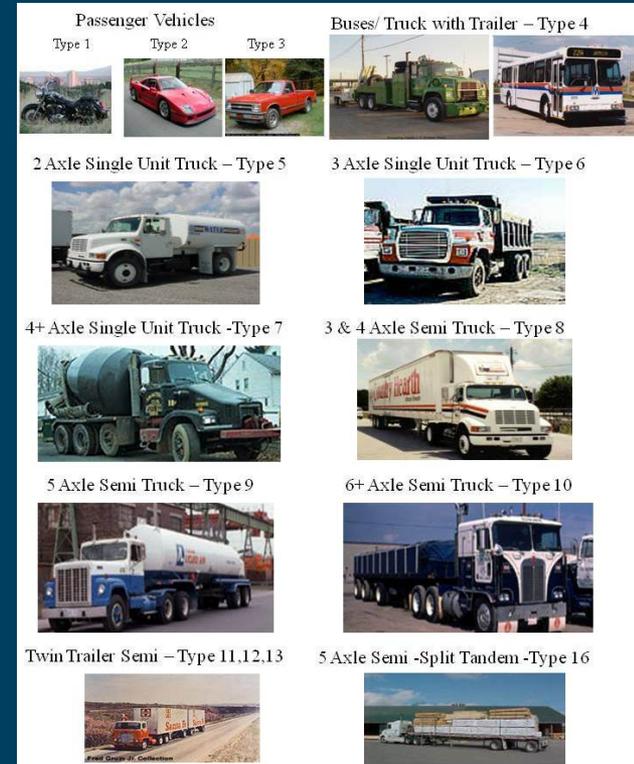


The primary concern is:  
*damage to the pavement  
caused by the wheel load.*



# What is Design ESAL

- ▶ Traffic mix is analyzed and converted into an equivalent number of 18,000 pound Single axle loads over the design life or analysis period of a pavement.
- ▶ For more information refer to Appendix D of AASHTO Guide for Design of Pavement Structures (1993).



# What is Design ESAL

Rather than a load, an ESAL should be thought of as:

ESAL = Damage factor



# BESAL vs. CESAL



# BESAL vs. CESAL

BESAL: Bituminous ESAL

CESAL: Concrete ESAL

- ▶ Each was developed from the AASHO Road Test by looking at resulting pavement damage and calculating ESAL's for each pavement type.
- ▶ Different equations are used to calculate the ESAL's for the two pavement types.
- ▶ No correlation between the two except:
  - $BESAL \approx CESAL \times 0.67$
  - $CESAL \approx BESAL \times 1.5$



*SALT*

*ESAL Calculator*



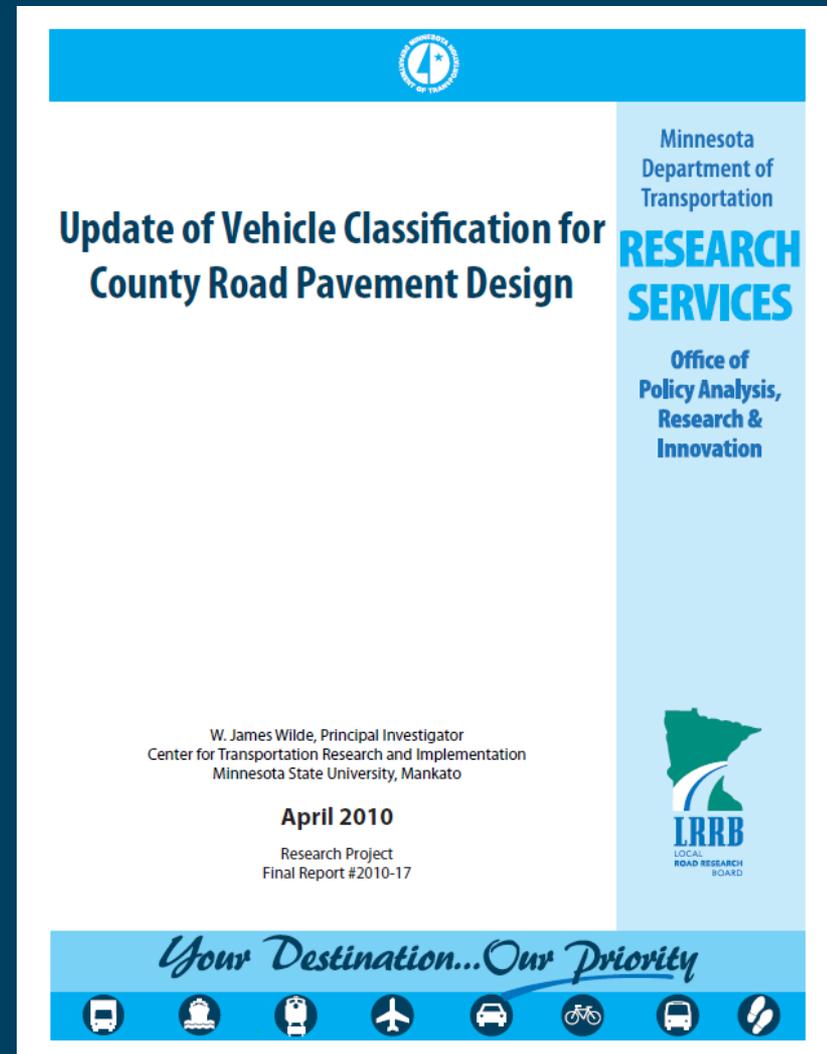
# SALT ESAL Calculator

- ▶ SALT ESAL Calculator was originally created by Joe Thomas and Tom Nordstrom in November of 2010.
- ▶ Similar to *“MinniESAL”*.
- ▶ Current version updated in March 2014.
- ▶ Is a two tab Excel spread sheet.
  - 1<sup>st</sup> tab – Default Heavy Commercial Traffic values.
  - 2<sup>nd</sup> tab – User defined site specific Heavy Commercial Traffic values.



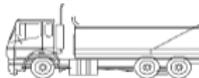
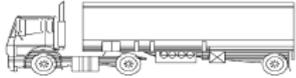
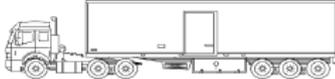
# SALT ESAL Calculator

Incorporates  
“Heavy Commercial Traffic”  
percentages obtained  
from LRRB  
Investigation 844



# SALT ESAL Calculator

## MnDOT VEHICLE CLASSIFICATION SCHEME

PASSENGER VEHICLES			
TYPE			
1	Motorcycle		MT
2	Car		Car
3	Truck Van		Car
SINGLE UNITS			
4	Bus Truck with trailer		MT
5	2 Axle Single Unit		MT
6	3 Axle Single Unit		HT
7	4+ Axle Single Unit		HT
COMBO UNITS			
8	3 & 4 Axle Semi		HT
9	5 Axle Semi		HT
10	6+ Axle Semi		HT
11, 12, 13	Twin Trailer Semi		HT

MT=Medium Truck  
HT=Heavy Truck

## Mn/DOT Vehicle Classification Scheme

### Passenger Vehicles

Type 1



Type 2



Type 3



### Buses/ Truck with Trailer – Type 4



2 Axle Single Unit Truck – Type 5



3 Axle Single Unit Truck – Type 6



4+ Axle Single Unit Truck -Type 7



3 & 4 Axle Semi Truck – Type 8



5 Axle Semi Truck – Type 9



6+ Axle Semi Truck – Type 10



Twin Trailer Semi – Type 11,12,13



5 Axle Semi -Split Tandem -Type 16



# SALT ESAL Calculator

## Default Heavy Commercial Traffic values

### Rural/Urban CSAH Heavy Commerical Percentages

Rural AADT Range	CAR	2ASU	3+ASU	3ASEMI	4ASEMI	5+ASEMI	TT/BUS	TWINS	Total	Average HC PCT	Range HC PCT
1 - 300	86.72%	4.71%	2.24%	0.35%	0.71%	3.81%	1.45%	0.01%	100.00%	<b>13.3%</b>	9 - 38%
301 - 750	86.56%	3.44%	2.17%	0.39%	0.69%	5.32%	1.40%	0.03%	100.00%	<b>13.4%</b>	4.7 - 34.3%
751 - 1500	90.55%	3.69%	1.71%	0.33%	0.57%	2.10%	1.03%	0.02%	100.00%	<b>9.5%</b>	2.2 - 29.0%
1500>	91.39%	2.32%	1.24%	0.16%	0.32%	3.33%	1.23%	0.01%	100.00%	<b>8.6%</b>	2.1 - 19.1%

Urban AADT Range	CAR	2ASU	3+ASU	3ASEMI	4ASEMI	5+ASEMI	TT/BUS	TWINS	Total	Average HC PCT	Range HC PCT
1 - 300	95.60%	1.60%	0.40%	0.40%	0.40%	0.40%	1.20%	0.00%	100.00%	<b>4.4%</b>	*N/A
301 - 750	92.53%	3.70%	1.62%	0.14%	0.24%	1.23%	0.48%	0.07%	100.00%	<b>7.5%</b>	4.0 - 11.0%
751 - 1500	94.72%	2.14%	0.98%	0.19%	0.30%	0.94%	0.71%	0.02%	100.00%	<b>5.3%</b>	1.1 - 10.6%
1500>	96.44%	1.52%	0.46%	0.09%	0.12%	0.89%	0.47%	0.02%	100.00%	<b>3.6%</b>	0.6 - 3.7%

Note: Data from 2007 and 2008 County State Aid Study (Minnesota State University) and 1986 to 2002 vehicle class data (MnDOT). Urban is defined as the area within the boundaries of a city 5000 or more population and the Twin Cities metropolitan area.

\*Data based on only one count, so there is no range.



# State Aid ESAL Traffic Forecast Calculator - 04/07/2014

This ESAL calculator is for use with **default Heavy Commercial Traffic values**; click "User Defined Traffic Values" sheet below if you wish to enter your own Heavy Commercial Traffic values.

Instructions: All yellow boxes require an input value.

Dropdown choices are provided for Base Year (C18), Number of Lanes (C19), and AADT Range (C20). You must click on cells C18, C19, and C20 to access the dropdown choices.

## General Information

Date

Forecast Performed by

Name of County or City

Project Number

Project Description

Route Number

Base Year (i.e. opening to traffic)

Number of Lanes (total both directions)

AADT Range

Historical AADT (enter a minimum of two years)

Enter oldest traffic data here

Enter second oldest traffic data here

Enter third oldest traffic data here

Enter fourth oldest traffic data here

Base Year AADT

20-Year AADT

35-Year AADT

Growth Rate

Year	AADT
<input type="text"/>	<input type="text"/>

Vehicle Type	Vehicle Class %	ESAL Factors	
		Flexible	Rigid
2AX-6TIRE SU		0.25	0.24
3AX+SU		0.58	0.85
3AX TST		0.39	0.37
4AX TST		0.51	0.53
5AX+TST		1.13	1.89
TR TR, BUSES		0.57	0.74
TWIN TRAILERS		2.40	2.33
<b>Total</b>	<b>0.00%</b>	<b>NA</b>	<b>NA</b>

20-Year Flexible Forecast =  
 20-Year Rigid Forecast =  
 35-Year Flexible Forecast =  
 35-Year Rigid Forecast =

For State Aid questions and information, please contact Joel Ulring (MnDOT State Aid) at 651-366-3831.

# SALT ESAL Calculator

## Tab 1: Default Heavy Commercial Traffic values.



# SALT ESAL Calculator

Yellow shaded cells require an input value.

Output values are in both BESAL's and CESAL's.

## State Aid ESAL Traffic Forecast Calculator - 04/07/2014

This ESAL calculator is for use with **default Heavy Commercial Traffic values**; click "User Defined Traffic Values" sheet below if you wish to enter your own Heavy Commercial Traffic values.

Instructions: All yellow boxes require an input value.

Dropdown choices are provided for Base Year (C18), Number of Lanes (C19), and AADT Range (C20). You must click on cells C18, C19, and C20 to access the dropdown choices.

### General Information

Date	25 August 2014
Forecast Performed by	Joel Ulring
Name of County or City	State Aid
Project Number	SAP or SP
Project Description	
Route Number	

Base Year (i.e. opening to traffic)	2015
Number of Lanes (total both directions)	2 = typical 2 lane
AADT Range	Rural: 751-1500

Historical AADT (enter a minimum of two years)	
Year	AADT
2003	814
2007	873
2011	944

Base Year AADT	2015	1,010
20-Year AADT	2035	1,330
35-Year AADT	2050	1,580
Growth Rate		1.58%

Vehicle Type	Vehicle Class %	ESAL Factors	
		Flexible	Rigid
2AX-6TIRE SU	3.69%	0.25	0.24
3AX+SU	1.71%	0.58	0.85
3AX TST	0.33%	0.39	0.37
4AX TST	0.57%	0.51	0.53
5AX+TST	2.10%	1.13	1.89
TR TR, BUSES	1.03%	0.57	0.74
TWIN TRAILERS	0.02%	2.40	2.33
<b>Total</b>	<b>9.45%</b>	<b>NA</b>	<b>NA</b>

20-Year Flexible Forecast = 268,000  
 20-Year Rigid Forecast = 379,000  
 35-Year Flexible Forecast = 509,000  
 35-Year Rigid Forecast = 719,000

For State Aid questions and information, please contact Malaki Ruranika (MnDOT State Aid) at 651-366-3825 or Joel Ulring (MnDOT State Aid) at 651-366-3831.



# SALT ESAL Calculator

Tab 2:  
User defined  
site specific Heavy  
Commercial  
Traffic values.  
Also allows traffic  
values to cross  
ADT ranges.

## State Aid ESAL Traffic Forecast Calculator - 04/07/2014

This ESAL calculator is for use with **site specific Heavy Commercial Traffic values**; click "Default Traffic Values" sheet below if you wish to use default Heavy Commercial Traffic values.

Instructions: All yellow boxes require an input value.

Dropdown choices are provided for Base Year (C18) and Number of Lanes (C19).

You must click on cells C18 and C19 to access the dropdown choices.

### General Information

Date	
Forecast Performed by	
Name of County or City	
Project Number	
Project Description	
Route Number	
Base Year (i.e. opening to traffic)	
Number of Lanes (total both directions)	

### Historical AADT (enter a minimum of two years)

Enter oldest traffic data here  
Enter second oldest traffic data here  
Enter third oldest traffic data here  
Enter fourth oldest traffic data here

Year	AADT

Base Year AADT

20-Year AADT

35-Year AADT

Growth Rate

Vehicle Type	Vehicle Class %	ESAL Factors	
		Flexible	Rigid
2AX-6TIRE SU		0.25	0.24
3AX+SU		0.58	0.85
3AX TST		0.39	0.37
4AX TST		0.51	0.53
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TWIN TRAILERS		2.40	2.33
<b>Total</b>	<b>0.00%</b>	<b>NA</b>	<b>NA</b>

20-Year Flexible Forecast =

20-Year Rigid Forecast =

35-Year Flexible Forecast =

35-Year Rigid Forecast =

For State Aid questions and information, please contact Joel Ulring (MnDOT State Aid) at 651-366-3831.



# *SALT ESAL Calculator*

ESAL Calculator is available on the SALT website:

[www.dot.state.mn.us/stateaid](http://www.dot.state.mn.us/stateaid)

Project Delivery

Plans, Design & Preparation

Pavement Design Tools and Information



# SALT ESAL Calculator



(bing.com)

For Questions Contact:

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*(651)366-3831*

