County Regional Representative Meeting

Truck Size & Weight

July 2, 2013

NDSU UPPER GREAT PLAINS TRANSPORTATION INSTITUTE

The U.S. Department of Transportation's Comprehensive Truck Size and Weight Study

&

Minnesota Truck Size and Weight Project

Two aspects of truck weight that are interdependent and that interact with the highway infrastructure:

- Axle weight (loading)
- Gross Vehicle Weight (GVW)

GVW - not the prime determinant of a vehicle’s impact on pavements.

Pavements - stressed by loads on individual axles and axle groups directly in contact with the pavement.

It is not GVW, but the distribution of the GVW over axles that impacts pavements.

Table VI-1
Highway Infrastructure Elements Affected by TS&W Limits

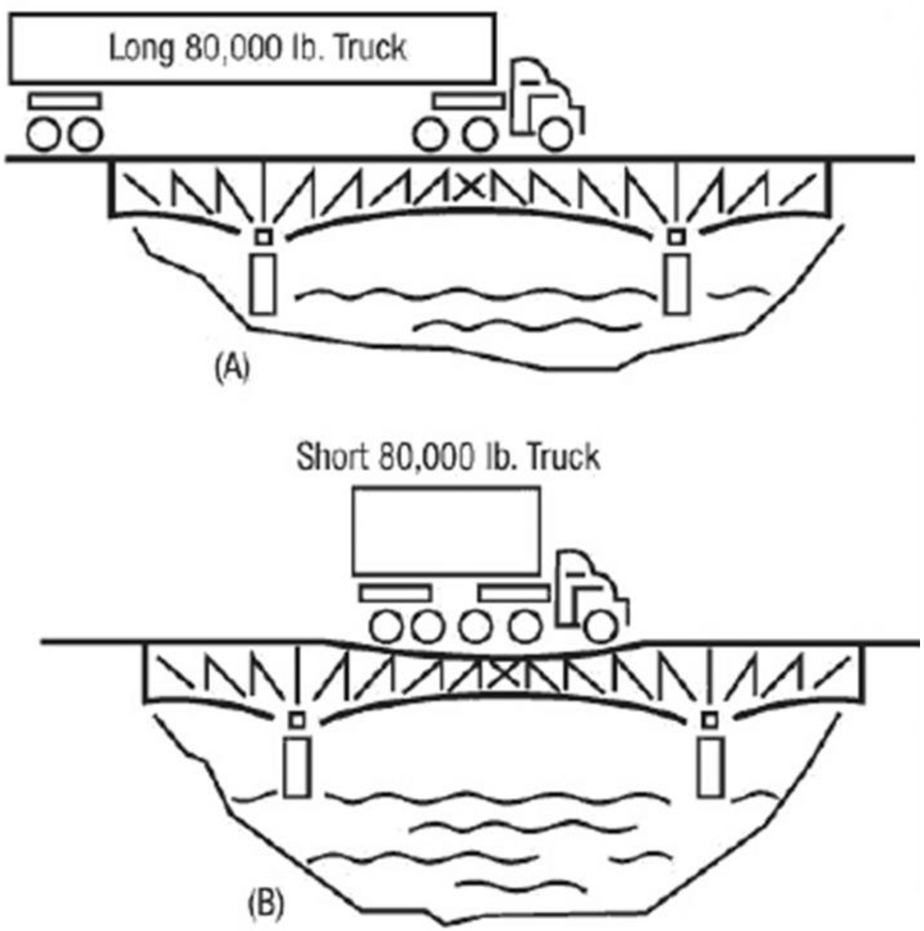
Highway Infrastructure Element		Axle Weight	GVW	Axle Spacing	Truck Length	Truck Width	Truck Height
Pavement	Flexible	E		E			
	Rigid	E		e			
Bridge Features	Short-Span	E		E	E		
	Long-Span		E	e	E		
	Clearance					e	E
Roadway Geometric Features	Interchange Ramps		e		E	e	
	Intersections				E	e	
	Climbing Lanes		E				
	Horizontal Curvature		e		e		
	Vertical Curve Length		E				
	Intersection Clearance Time		E		E		
	Passing Sight Distance				e		

Key: E = Significant Effect
e = Some Effect

Axle groups, such as tandems or tridems, distribute the load along the pavement, allowing greater weights to be carried and resulting in the same or less pavement distress than that occasioned by a single axle at a lower weight.

GVW *is* a factor for the life of long-span bridges -- that is, bridge spans longer than the wheelbase of the truck.

Bridge bending stress is more sensitive to the spread of axles than to the number of axles.



Axle spacing is as important as axle weight in designing bridges. In Figure A, the stress on bridge members as a longer truck rolls across is much less than that caused by a short vehicle as shown in Figure B, even though both trucks have the same total weight and individual axle weights. The weight of the longer vehicle is spread out, while the shorter vehicle is concentrated on a smaller area.

Roads - designed to accommodate projected heavy vehicle axle loads.

Design is based on axle weights, not GVW.

Equivalent Single Axle Load (ESAL) concept - measures effect of heavy vehicles on pavements.

Conventional five-axle tractor-semitrailer operating at 80,000 pounds gross vehicle weight (GVW) is equivalent to about 2.4 ESALs.

If the weight of this vehicle was increased to 90,000 pounds (a 12.5 percent increase), its ESAL value goes up to 4.1 (a 70.8 percent increase), because pavement damage increases at a geometric rate with weight increases.

However, a six-axle tractor-semitrailer at 90,000 pounds has an ESAL value of only 2.0, because its weight is distributed over six axles instead of five.

An added pavement benefit of the 90,000-pound six-axle truck is that fewer trips are required to carry the same amount of payload, resulting in significantly less pavement damage.

Effect of trucks on pavements is not constant throughout the calendar year.

Winter - less damage to pavements than at other times of the year.

Spring - traffic loading during spring thaw results in five to eight times more damage to pavements than that same loading at other times of the year.

The key finding of the MN Truck Size & Weight Project was that four heavier truck configurations were found feasible and generated net statewide benefits.

The evaluation considered transport savings, pavement costs, bridge inspection costs, rating and posting impacts, bridge fatigue and deck wear effects, increased bridge design load requirements, safety, and congestion.

Configuration	Total ESALs
Current 5-axle tractor-semitrailer at 80,000 lbs.	2.4
6-axle tractor-semitrailer at 90,000 lbs.	2.0
7-axle tractor-semitrailer at 97,000 lbs.	1.5
8-axle double at 108,000 lbs.	1.8
Single unit 6- and 7-axle respectively	0.7 and 0.9

Increased payloads and fewer truck trips will lower transport costs significantly.

Additional axles and fewer truck trips will result in less pavement wear and possible safety increase.

A modest increase in bridge postings and future design costs will be necessary.

Road Type	Lane Mileage	Sq. Ft. of Pavement	Replacement Cost per sq. ft.	Total Replacement Cost	Design Life in ESALS
State Highway	1000	63,660	$4.75	$302,385	200,000

A typical 80,000 pound 5-axle TST has a payload of 49,500 pounds and generates 2.4 ESAL per trip.

A 5-axle TST at 90,000 pounds has a payload of 59,500 pounds and generates 4.1 ESAL per trip.

If the annual agricultural harvest generates 100,000,000 pounds of produce, how many trips will each vehicle make to move the products to market?
__________ trips by 5-axle 80,000 lb TST
__________ trips by 5-axle 90,000 lb TST

How many ESALs will each vehicle generate?
__________ ESALs by the 5-axle 80,000 lb TST
__________ ESALs by the 5-axle 90,000 lb TST

How many years will the highway pavement last under use by each vehicle type?
__________ years with the 5-axle 80,000 lb TST
__________ years with the 5-axle 90,000 lb TST

What is the annual cost for replacing the highway pavement for each vehicle type?
__________ per year for the 5-axle 80,000 lb TST
__________ per year for the 5-axle 90,000 lb TST

Road Type	Lane Mileage	Sq. Ft. of Pavement	Replacement Cost per sq. ft.	Total Replacement Cost	Design Life in ESALS
State Highway	1000	63,660	$4.75	$302,385	200,000

A typical 80,000 pound 5-axle TST has a payload of 49,500 pounds and generates 2.4 ESAL per trip.

A 5-axle TST at 90,000 pounds has a payload of 59,500 pounds and generates 4.1 ESAL per trip.

If the annual agricultural harvest generates 100,000,000 pounds of produce, how many trips will each vehicle make to move the products to market?

__2020_____ trips by 5-axle 80,000 lb TST
__1681_____ trips by 5-axle 90,000 lb TST

How many ESALs will each vehicle generate?

__4848_____ ESALs by the 5-axle 80,000 lb TST
__6892_____ ESALs by the 5-axle 90,000 lb TST

How many years will the highway pavement last under use by each vehicle type?

__41.3______ years with the 5-axle 80,000 lb TST
__29.0______ years with the 5-axle 90,000 lb TST

What is the annual cost for replacing the highway pavement for each vehicle type?

__$7322____ per year for the 5-axle 80,000 lb TST
__$10,427_ per year for the 5-axle 90,000 lb TST

Road Type	Lane Mileage	Sq. Ft. of Pavement	Replacement Cost per sq. ft.	Total Replacement Cost	Design Life in ESALS
State Highway	1000	63,660	$4.75	$302,385	200,000

A typical 80,000 pound 5-axle TST has a payload of 49,500 pounds and generates 2.4 ESAL per trip.

A 6-axle TST at 90,000 pounds has a payload of 58,500 pounds and generates 2.0 ESAL per trip.

If the annual agricultural harvest generates 100,000,000 pounds of produce, how many trips will each vehicle make to move the products to market?

___________ trips by 5-axle 80,000 lb TST

___________ trips by 6-axle 90,000 lb TST

How many ESALs will each vehicle generate?

___________ ESALs by the 5-axle 80,000 lb TST

___________ ESALs by the 6-axle 90,000 lb TST

How many years will the highway pavement last under use by each vehicle type?

___________ years with the 5-axle 80,000 lb TST

___________ years with the 6-axle 90,000 lb TST

What is the annual cost for replacing the highway pavement for each vehicle type?

___________ per year for the 5-axle 80,000 lb TST

___________ per year for the 6-axle 90,000 lb TST

Road Type	Lane Mileage	Sq. Ft. of Pavement	Replacement Cost per sq. ft.	Total Replacement Cost	Design Life in ESALS
State Highway	1000	63,660	$4.75	$302,385	200,000

A typical 80,000 pound 5-axle TST has a payload of 49,500 pounds and generates 2.4 ESAL per trip.

A 6-axle TST at 90,000 pounds has a payload of 58,500 pounds and generates 2.0 ESAL per trip.

If the annual agricultural harvest generates 100,000,000 pounds of produce, how many trips will each vehicle make to move the products to market?

__2020____ trips by 5-axle 80,000 lb TST
__1710____ trips by 6-axle 90,000 lb TST

How many ESALs will each vehicle generate?

__4848____ ESALs by the 5-axle 80,000 lb TST
__3420____ ESALs by the 6-axle 90,000 lb TST

How many years will the highway pavement last under use by each vehicle type?

__41.3_____ years with the 5-axle 80,000 lb TST
__58.5_____ years with the 6-axle 90,000 lb TST

What is the annual cost for replacing the highway pavement for each vehicle type?

__$7322___ per year for the 5-axle 80,000 lb TST
__$5169___ per year for the 6-axle 90,000 lb TST

Table V-3. Theoretical Load Equivalency Factors Per 100,000 Pounds of Payload

Configuration	Gross Vehicle Weight (pounds)	Empty Weight (pounds)	Payload Weight (pounds)	No. Of Vehicles per 100,000 pounds of payload	Load Equivalency Factors		
					Rigid Pavement Fatigue (10-inch thickness)	Flexible Pavement (5-inch wearing surface)	
						Fatigue	Rutting
Three-Axle Single Unit Truck	54,000	22,600	31,400	3.18	13.4	17.8	13.0
Four-Axle Single Unit Truck	64,000	26,400	37,600	2.66	9.6	14.4	12.2
	71,000	26,400	44,600	2.24	9.2	14.6	11.2
Five-Axle Semitrailer	80,000	30,500	49,500	2.02	5.7	9.3	10.3
Five-Axle Semitrailer (10-foot Spread)	80,000	30,500	49,500	2.02	6.3	12.2	10.9
Six-Axle Semitrailer	90,000	31,500	58,500	1.71	3.8	7.5	9.6
	97,000	31,500	65,500	1.53	4.1	8.4	9.2
STAA Double (five-axle)	80,000	29,300	50,700	1.97	8.3	9.9	9.7
B-Train Double (eight-axle)	124,000	38,700	85,300	1.17	3.9	7.0	7.6
	131,000	38,700	92,300	1.08	4.1	7.7	7.5
Rocky Mt.Double (seven-axle)	120,000	43,000	77,000	1.30	7.8	9.9	9.5
Turnpike Double (nine-axle)	148,000	46,700	101,300	0.99	5.0	7.7	7.2
Triple (seven-axle)	114,000 (LTL operation)*	44,500	69,500	1.44	8.6	9.8	9.6
	132,000 (TL operation)**	44,500	87,500	1.14	11.6	11.8	9.0

*LTL= Less-than-truckload
**TL= Truckload

Summary

Posting a road to a higher GVW can be beneficial to public and private entities.

Challenge is to find balance in truck size and weight versus impacts.

Additional axles and fewer truck trips can result in less pavement wear and possible increase in safety.

Thank You!

Questions?