RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

BUREAU OF RESEARCH

NJDOT TECHNOLOGY TRANSFER
RESEARCH SHOWCASE
– LUNCHTIME EDITION

ANALYSIS OF OVERWEIGHT TRUCK PERMIT POLICY IN NEW JERSEY

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Outline

- Introduction
- NJ Overweight Permit Database
- Damage Cost Analysis Methodology
- Comparison of Permit Policies in the U.S.
- Conclusions and Recommendations

Introduction

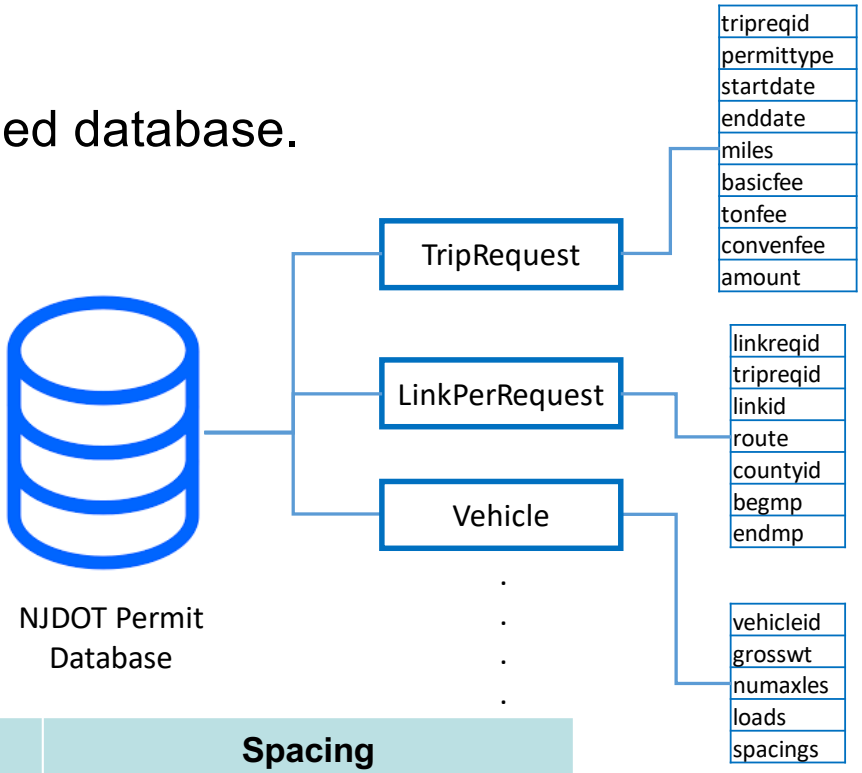
- Legal trucks (GVW < 80 kips) exert a level of damage to the infrastructure.
- However, **overweight (OW) trucks damage** the infrastructure beyond the level caused by legal trucks (taken as baseline).
- Thus, only ”marginal” damage cost should be accounted for to estimate the infrastructure damage due to OW trucks.
- **NJ legislation** requires operators of OW trucks to obtain permit for a fee to use the infrastructure based on the types of goods carried.

I-35W Mississippi River Bridge Collapse

Question: ***Can the revenues from the permit fees recoup part or all the cost of the actual damage that they incur on the infrastructure?***

NJ Overweight Permit Database

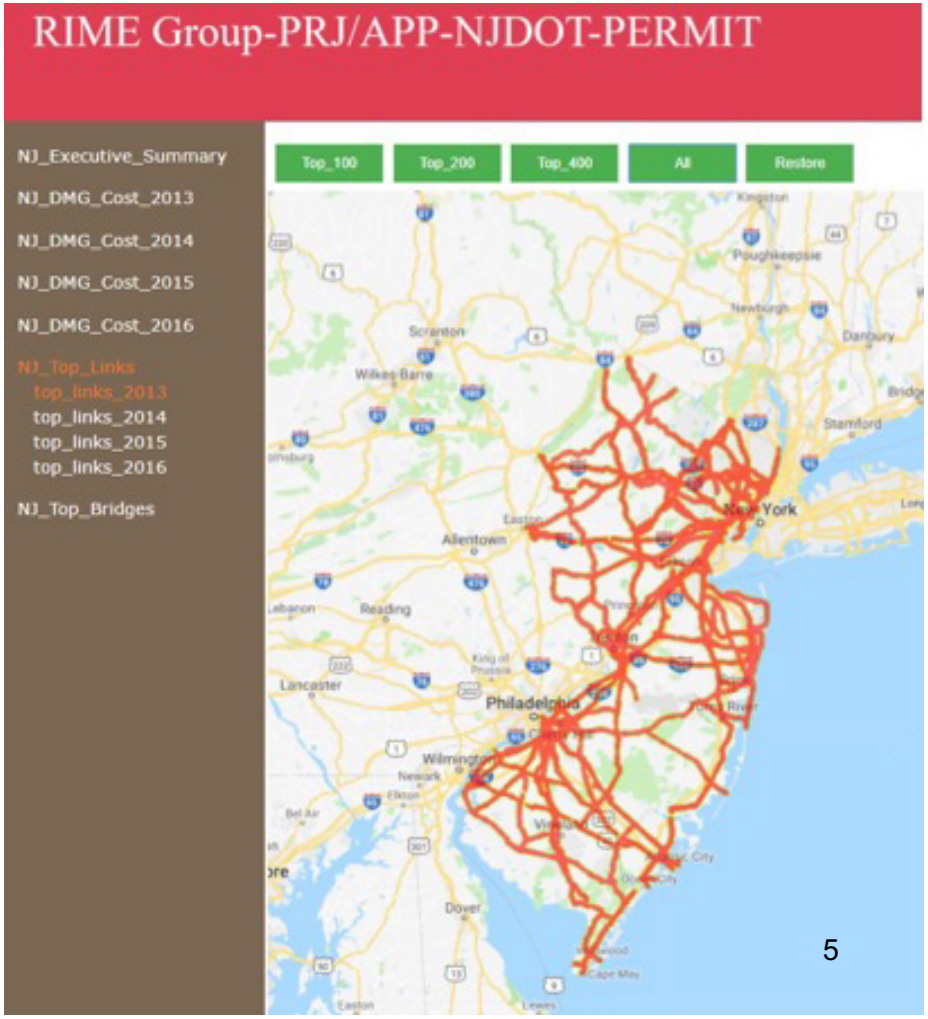
- Three tables were used to develop a unified database.
  - TripRequest
  - LinkPerRequest
  - Vehicle
- **RDBMS**: Relational Data Management System using Microsoft SQL Server.
- **Data Validation**: filtered permit records with missing axle weight and spacing data



Vehicle ID	GVW (lbs.)	Num Axles	Axle Weight (lbs.)	Spacing
102935	80000	3	12000,34000,34000	1' 0", 1' 0"
100013	80000	5	…	LEGAL, LEGAL, LEGAL, LEGAL

NJ Overweight Permit Database

- The data was processed by means of a GIS/ Web-Based application using the following:
- NJ **Straight Line Diagrams (SLD):** Necessary data to generate a geographic layer so that the links on the NJ roadway network can be displayed on the map.
- **The National Bridge Inventory (NBI) data:** Properties and locations of all the bridges maintained by NJDOT, which is needed as input for the bridge deterioration models.



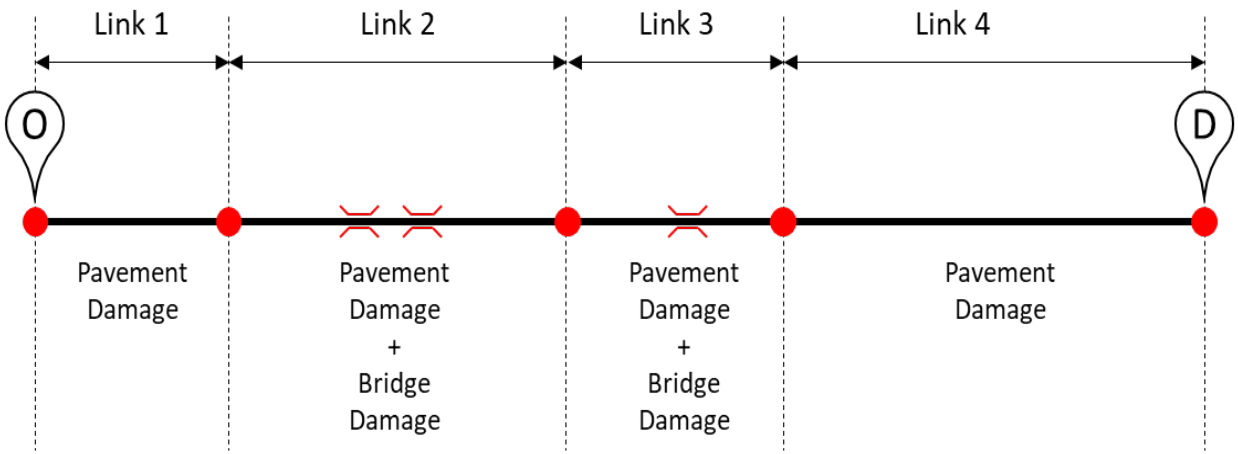
NJ Overweight Permit Types

Type	Validity	Fee Schedule	Weight Rules
Single Trip	5 days	$10 Base Fee **+ OW Tonnage Fee *** + $12 Transaction Fee + 5% Service Fee	• GVW ≤ 80,000 lbs. • Single ≤ 22,400 lbs. • Tandem ≤ 34,000 lbs. • Tridem ≤ 56,400 lbs. • Federal Bridge Formula (FBF).
Code 23 (single trip)	30 days	$209.50 Annual Trailer Registration Fee + $12 Transaction Fee + 5% Service Fee	• Wheel ≤ 800 lbs. per inch of tire width • Same as Single Trip Weight Rules
Ocean Borne Container	365 days	$100 Base Fee + $12 Transaction Fee + 5% Service Fee	• GVW ≤ 90,000 lbs. • Tandem ≤ 38,000 lbs. • Tridem ≤ 56,400 lbs.

- **OW Tonnage Fee**: ***$5.00 per ton or fraction thereof in excess of the weight Rules.***

Damage Cost Analysis Methodology

- Trip route information (links) and vehicle configuration (weight and spacing) were used to calculate the link level damage costs for pavement and bridge using advanced infrastructure deterioration models (Nassif et al. (2015)*)



Bridge Damage Cost (BDC) = UBC x Area x GVW

UBC = Unit Bridge Cost ($/kips-ft^2)
GVW = GVW of Permit Vehicle (kips)
Area = Total Sq. Ft. of the Bridge(ft^2)

Pavement Damage Cost (PDC) = ESAL x UPC x Miles x Lane

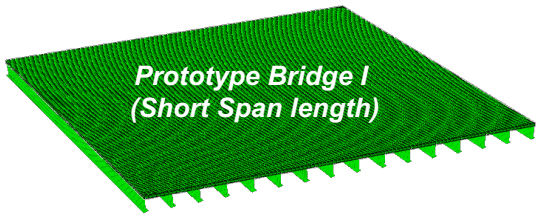
ESAL = Equi. Single Axle Load (1/kips)
UPC = Unit Pavement Cost ($/ESAL/mile/lane)
Lane = Number of Lanes

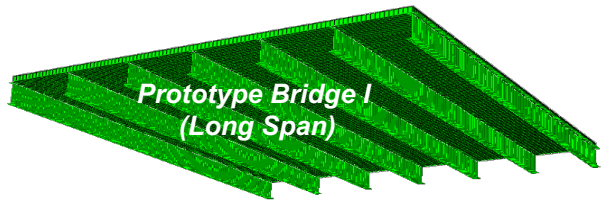
OW Damage = Bridge Damage + Pavement Damage

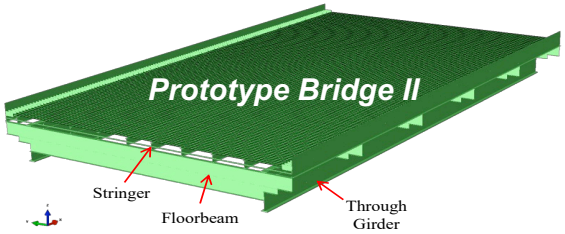
* Nassif, H., Ozbay, K., Wang, H., Noland, B., Lou, P. Demiroluk, S., Su, D., Na, C., (2015) "Impact of Freight on Highway Infrastructure in New Jersey," FHWA-NJ-2016-004, Final Report submitted to NJDOT, March, 225 pp.

Damage Cost Analysis Methodology

- **Bridge Damage** calculation involves using finite element modeling and estimation of the service life of different types of bridge decks and girders for concrete and steel. The cost impact of OW trucks on bridges is quantified using the Bridge Life-Cycle Cost Analysis (BLCCA). These costs are later converted to unit damage costs based on bridge type (Nassif et al. (2015)*).







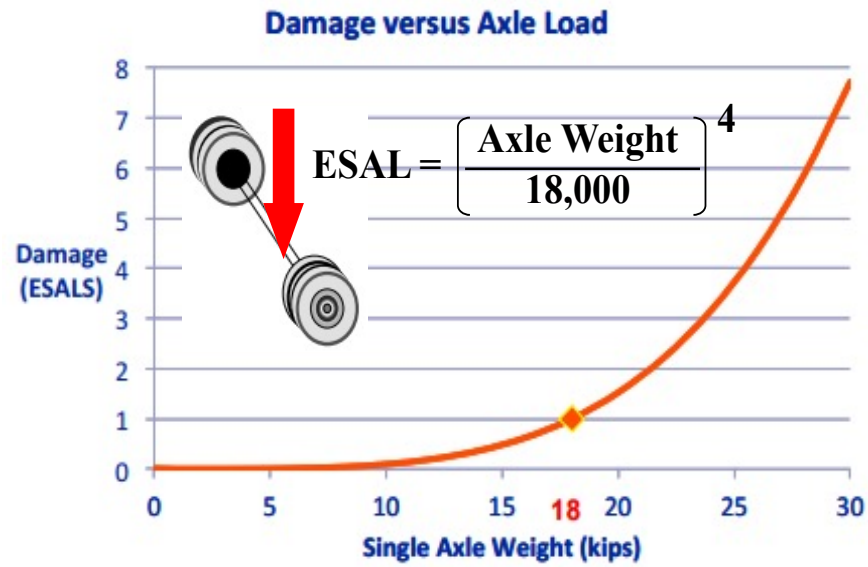
FE models were established to predict the stress ranges of selected bridges under site-specific truck weight (fatigue truck). Then AASHTO approach was used to estimate the remaining fatigue life of the bridge.

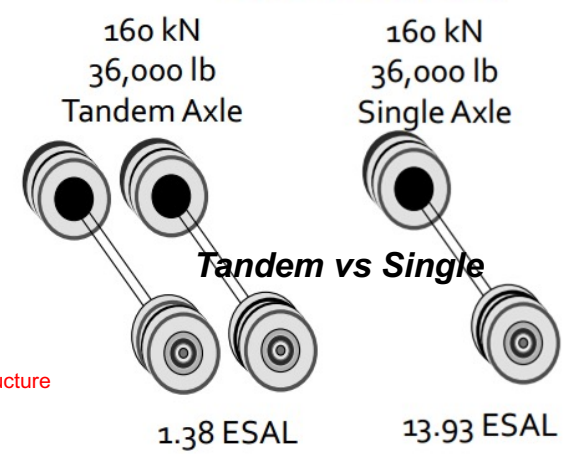
Structural member	Critical location	Δf (ksi)	Δf_{LL+IM} (ksi)	Δf_{eff} (ksi)	$(\Delta f_{eff})_{max}$ (ksi)	Remaining fatigue life prediction by AASHTO
						Category D
Stringer	Midspan	4.65	5.35	3.62	7.24	57 (evaluation life) 32 (minimum life) 83 (mean life)

* Nassif, H., Ozbay, K., Wang, H., Noland, B., Lou, P. Demiroluk, S., Su, D., Na, C., (2015) "Impact of Freight on Highway Infrastructure in New Jersey," FHWA-NJ-2016-004, Final Report submitted to NJDOT, March, 225 pp.

Damage Cost Analysis Methodology

- **Pavement Damage** calculation involves allocating asphalt pavement damage cost induced by different truck loading. Load equivalency factors (LEFs) were developed from M-E analysis and used to convert truck traffic to the number of ESAL that would yield the same impact on the pavement. Pavement life is predicted using WIM data and typical pavement designs in New Jersey (Nassif et al. (2015)*).





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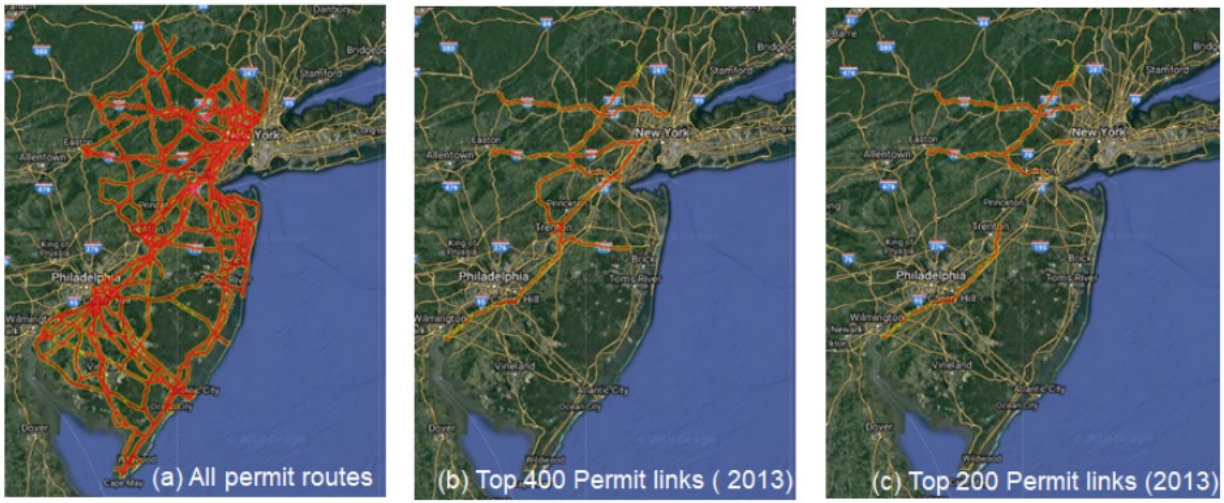
OW Permit Statistics



- **Major Corridors for Permit Trucks**
  - *Top 200: I-78, I-80, I-287, I-295, US-1, I-95M*
  - *Top 400: I-78, I-80, I-287, I-295, US-1, I-95M, US-202, I-195, NJ-31, I-95, NJ-440, US-1T, NJ-42, and US-130*

Typical OW Permit Vehicle

Avg. Travelled Miles	Avg. GVW	Avg. ESAL
50 miles	120 kips	8.5

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OW Permits with OW Tonnage Fee

OW Permits that do not pay OW Tonnage Fee

OW Permit Statistics

Year	All Permit Count (OS&OW)	Permit Category					
		Single Trip OS&OW[1]	Single Trip only OS[2]	Single Trip OS/OW (Code 23)[3]	Single Trip OS only (Code 23)[4]	Ocean-Borne[5]	Others[5]
2011	82,535	16,352	37,688	19,917	4,231	2,487	1,860
2012	89,412	18,302	42,823	19,248	4,466	2,839	1,734
2013	96,534	21,498	45,153	20,538	4,035	3,439	1,871
2014	102,287	23,006	48,819	21,092	3,966	3,410	1,994
2015	103,347	23,996	47,071	23,539	3,051	3,585	2,105
2016	108,420	26,529	45,344	27,455	2,321	4,396	2,375
2017	111,975	28,378	46,685	26,733	2,589	4,983	2,607
2018	107,460	28,930	45,177	23,874	2,747	4,303	2,429
Total	801,970	186,991	358,760	182,396	27,406	29,442	16,975
Avg.	**100,246**	**23,374**	**44,845**	**22,800**	**3,426**	**3,680**	**2,122**
Ratio	**100%**	**23%**	**45%**	**23%**	**3%**	**4%**	**2%**

[1] OS/OW Fee; [2] OS Fee; [3] No OS/OW fee is charged, but only the fixed administrative fee of $12.6 is applied. [4] The OS fee in addition to the fixed administrative fee of $12.6 is applied.; [5] No fee ($0).

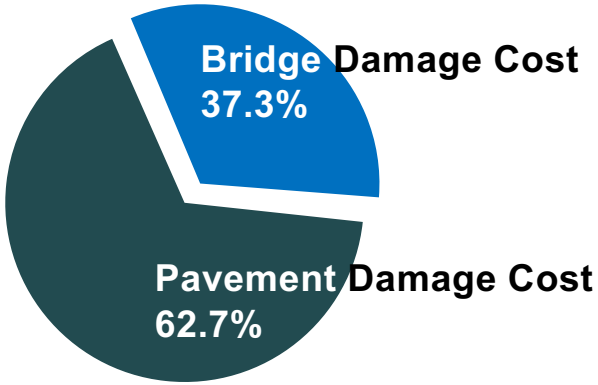
All Permit Trucks = 100,246 (100%)

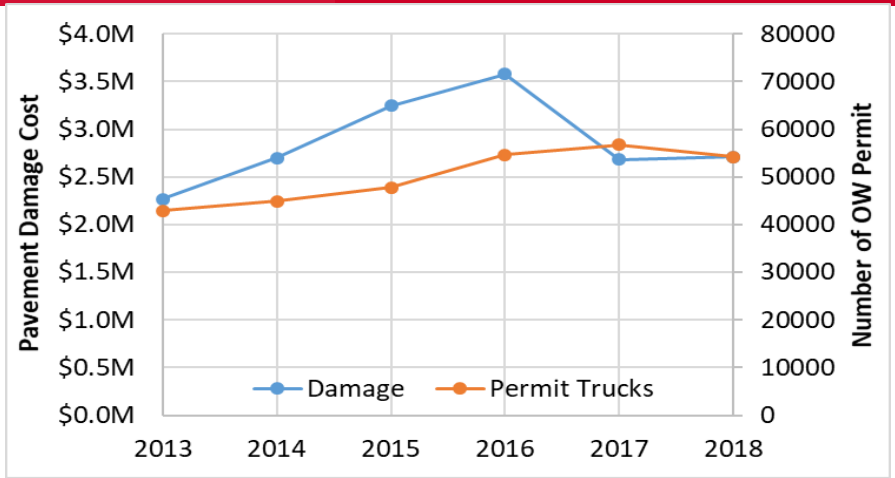
Paid** OW Permit = **23,374 (23%)

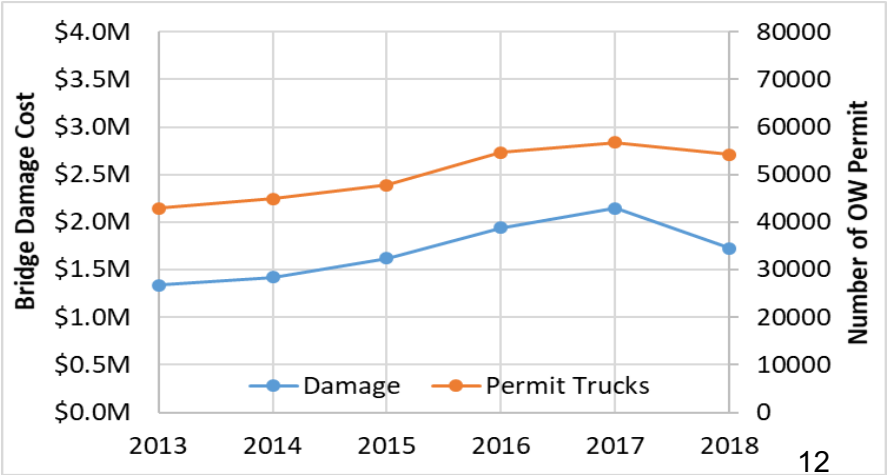
OW Permit Trucks = 46,174 (46%)

Bridge & Pavement Damage Cost

- Bridge Damage Cost:
  - $142,104 per month
  - $1,705,244 per year
- Pavement Damage Cost
  - $238,571 per month
  - $2,862,858 per year

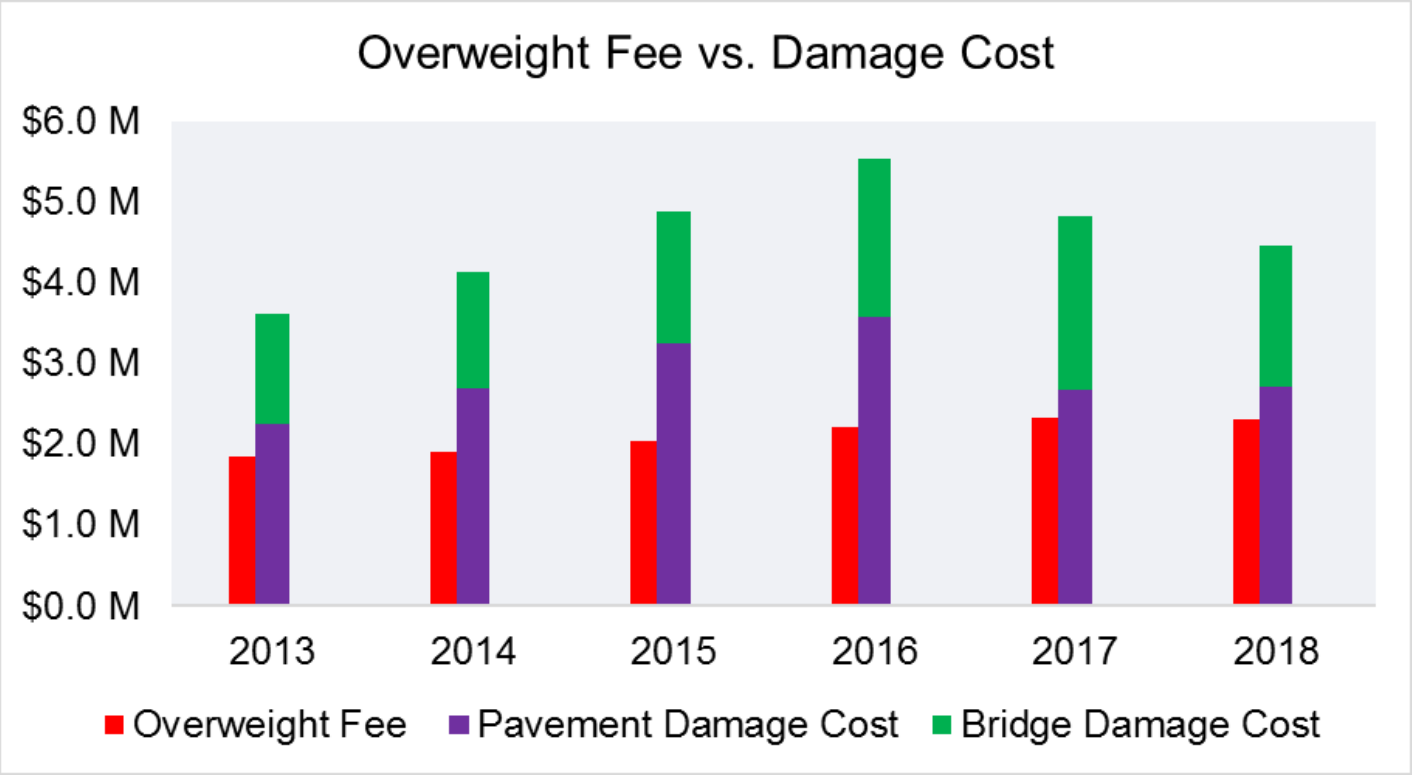






Collected Fee vs OW Permit Fee

- The collected OW fee accounted for only 46% of the estimated damage cost due to the permit trucks



Type	Cost/Fee
Bridge Damage Cost	$1,705,244
Pavement Damage Cost	$2,862,858
Total Damage Cost	$4,568,102
Overweight Permit Fee	$2,105,112

Collected Fee vs OW Permit Fee

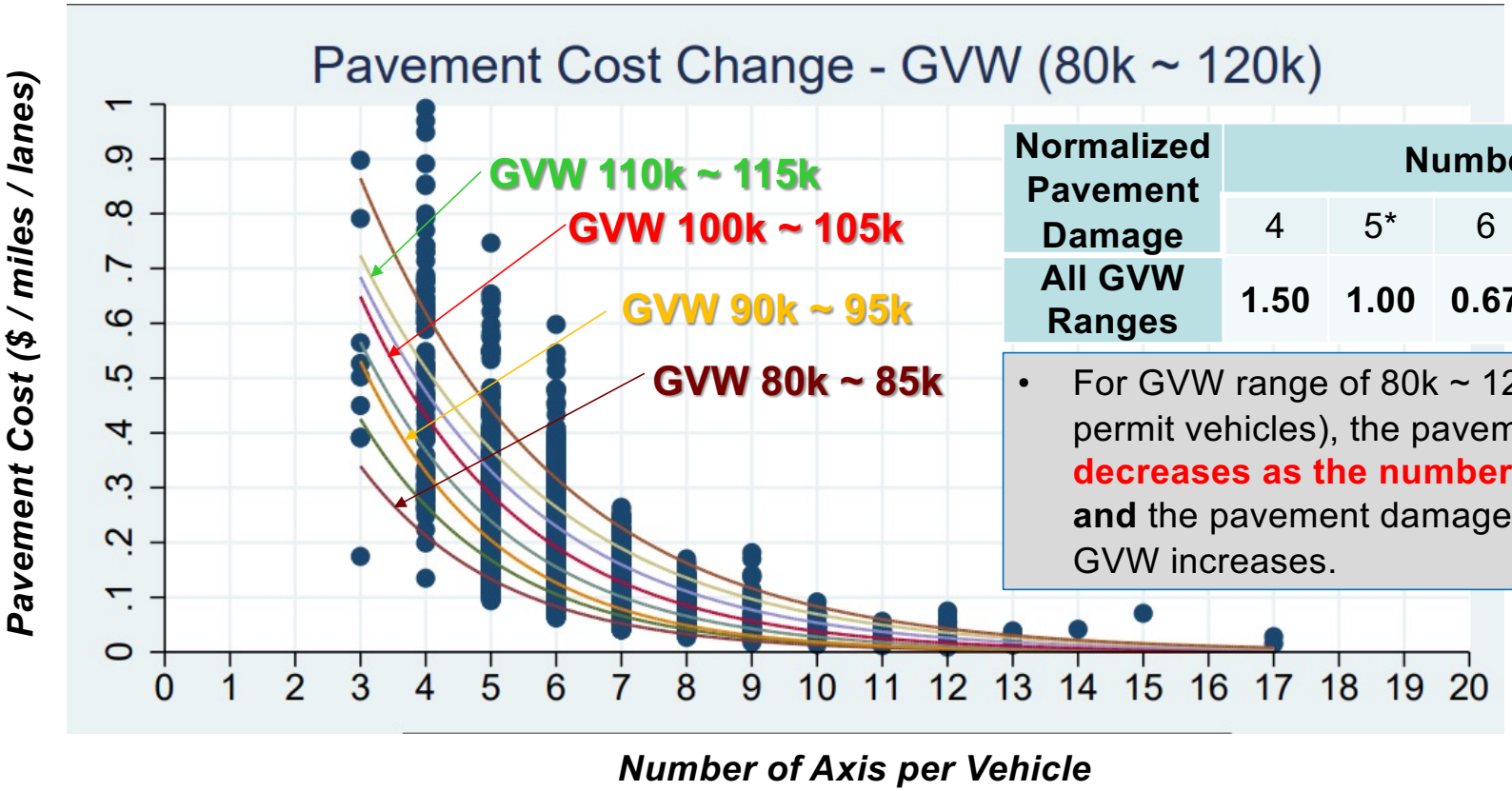
Year	Collected Basic Fees for OW Permit*		Collected Single Trip OW Tonnage Fee	Estimated Damage Cost (Pavement + Bridge)		
	Single Trip Permit	Code 23 Permit		Total Damage	Single Trip OW Permit Damage	Single Trip OS/OW Permit for Code 23 Damage
2013	$496,604	$258,779	$1,842,500	$3,611,636	$1,944,845	$1,666,791
2014	$531,439	$265,759	$1,903,905	$4,122,809	$2,316,187	$1,806,621
2015	$554,308	$296,591	$2,047,151	$4,872,564	$2,927,491	$1,945,072
2016	$612,820	$345,933	$2,211,364	$5,525,039	$3,316,982	$2,208,057
2017	$655,532	$336,836	$2,321,367	$4,823,001	$2,360,062	$2,462,939
2018	$668,283	$300,812	$2,304,382	$4,453,564	$2,318,240	$2,135,323
Average	$586,497	$300,785	**$2,105,112**	$4,568,102	**$2,530,635**	**$2,037,467**

* Basic fee = base fee $10 + transaction fee $12 (service fee 5% not included).

- Collected single trip OW tonnage fee is 83% of single trip OW permit damage.
- However, single trip OW permit damage is only 55% of total damage due to OW permits which also include Code 23 OW permits.
- Therefore, actual single trip OW tonnage fee is 46% of total OW damage.

Effect of Including an Additional Axle to Reduce Damage

- Additional axle would help reduce the pavement damage.

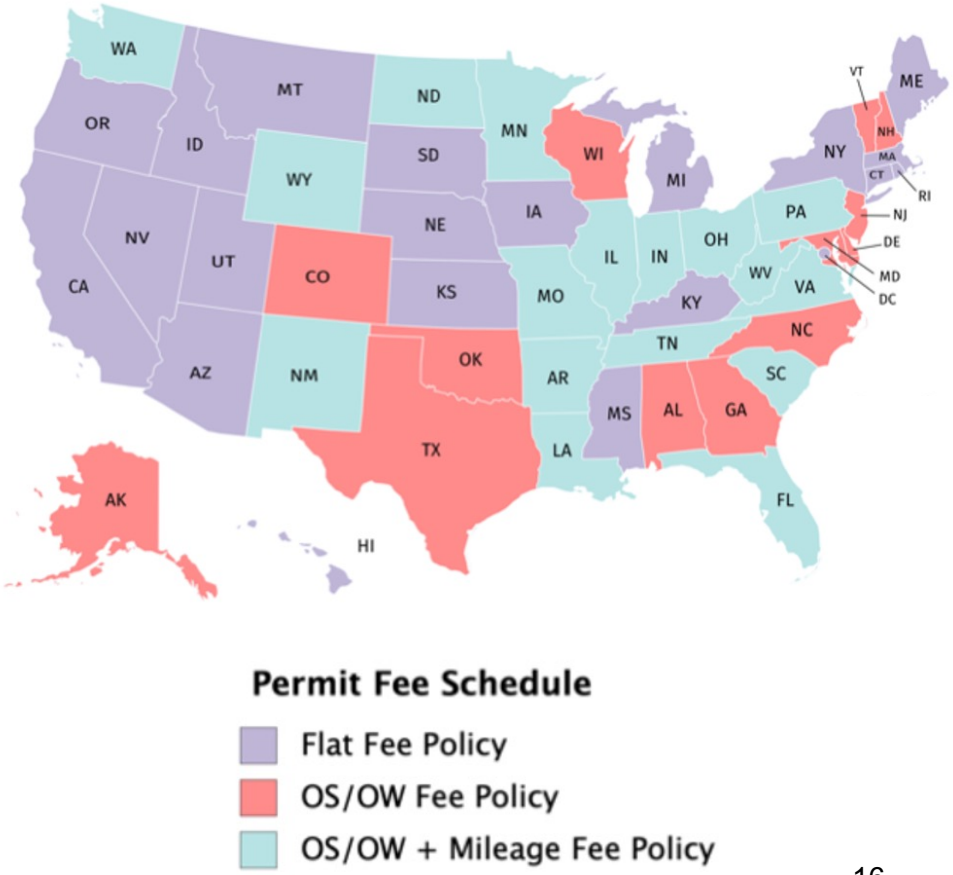


Normalized Pavement Damage	Number of Axle					
	4	5*	6	7	8	9
All GVW Ranges	**1.50**	**1.00**	**0.67**	**0.45**	**0.30**	**0.20**

- For GVW range of 80k ~ 120k (60% of all the permit vehicles), the pavement damage cost **decreases as the number of axle increases and** the pavement damage cost increases as GVW increases.

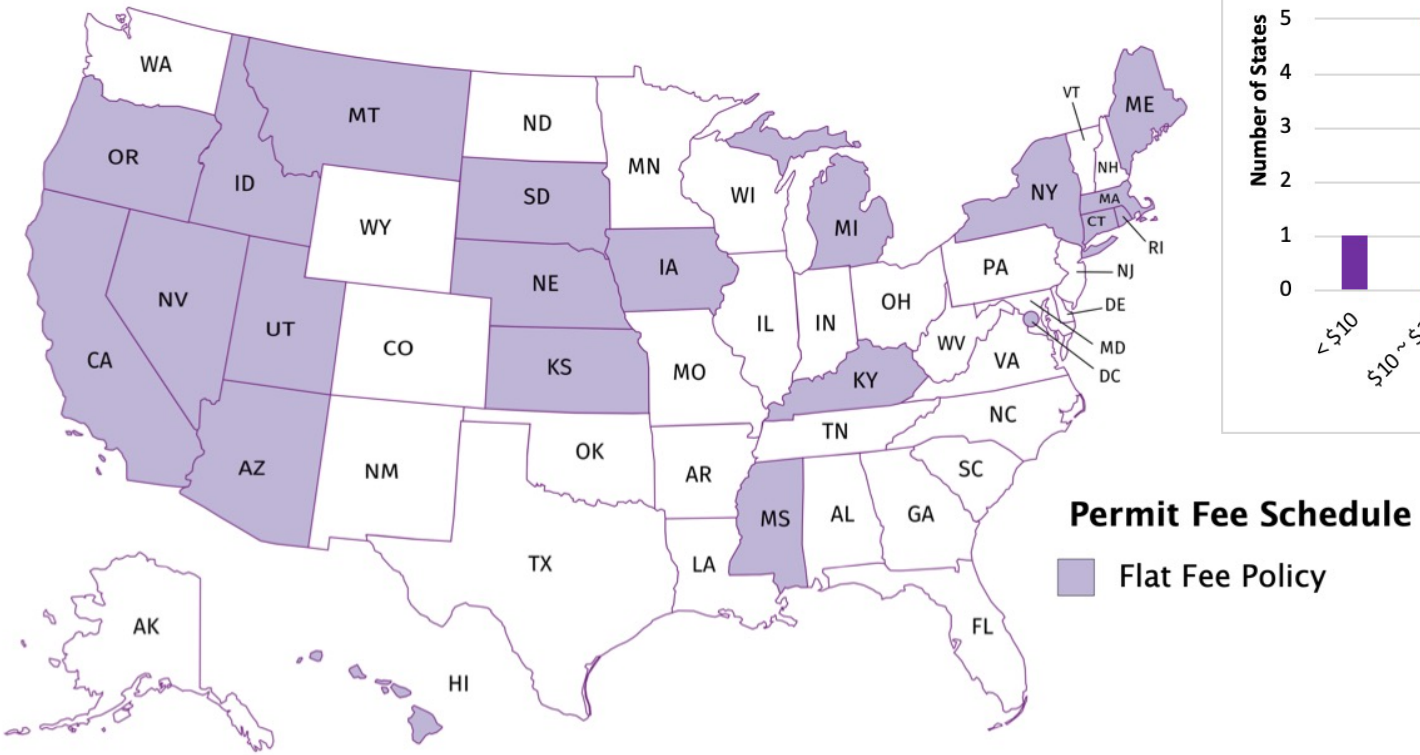
Comparison of Permit Policies in the U.S.

Fee Schedule	No. of States	West (AK/HI)	Mid-West	South	North-East
Flat Fee	21	OR, ID, MT, CA, NV, UT, AZ, HI (8)	SD, NE, KS, IA, MI (5)	KY, MS, D.C. (3)	NY, CT, MA, RI, ME (5)
OS/OW Fee	13	AK, CO (2)	WI (1)	TX, OK, AL, GA, NC, MD, DE (7)	NJ, VT, NH (3)
OS/OW +Milage Fee	17	WA, WY, NM (3)	ND, MN, MO, IL, IN, OH (6)	AR, LA, TN, VA, WV, SC, FL (7)	PA (1)
Total	**51**	**13**	**12**	**17**	**9**



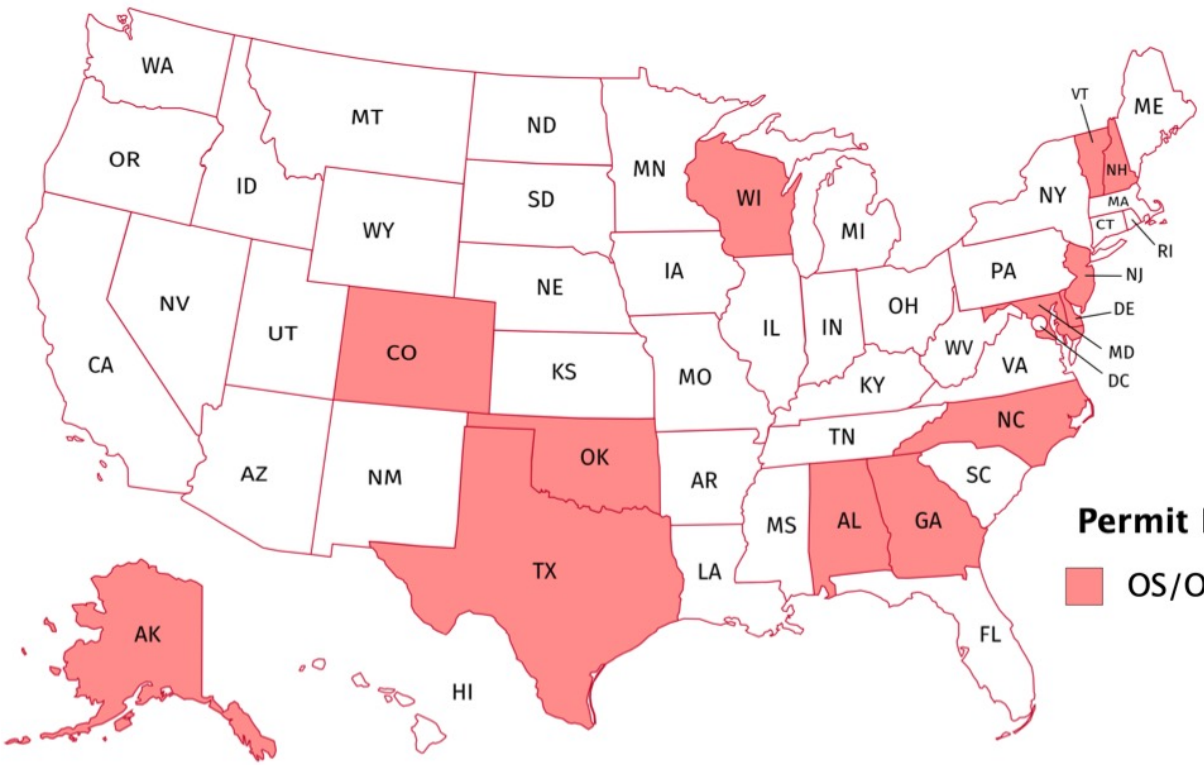
Comparison of Permit Policies in the U.S.

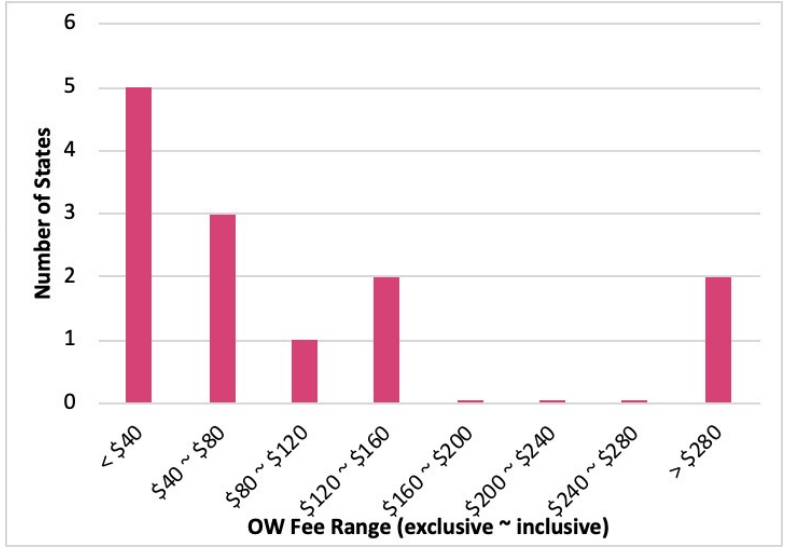
- Flat Fee State



Comparison of Permit Policies in the U.S.

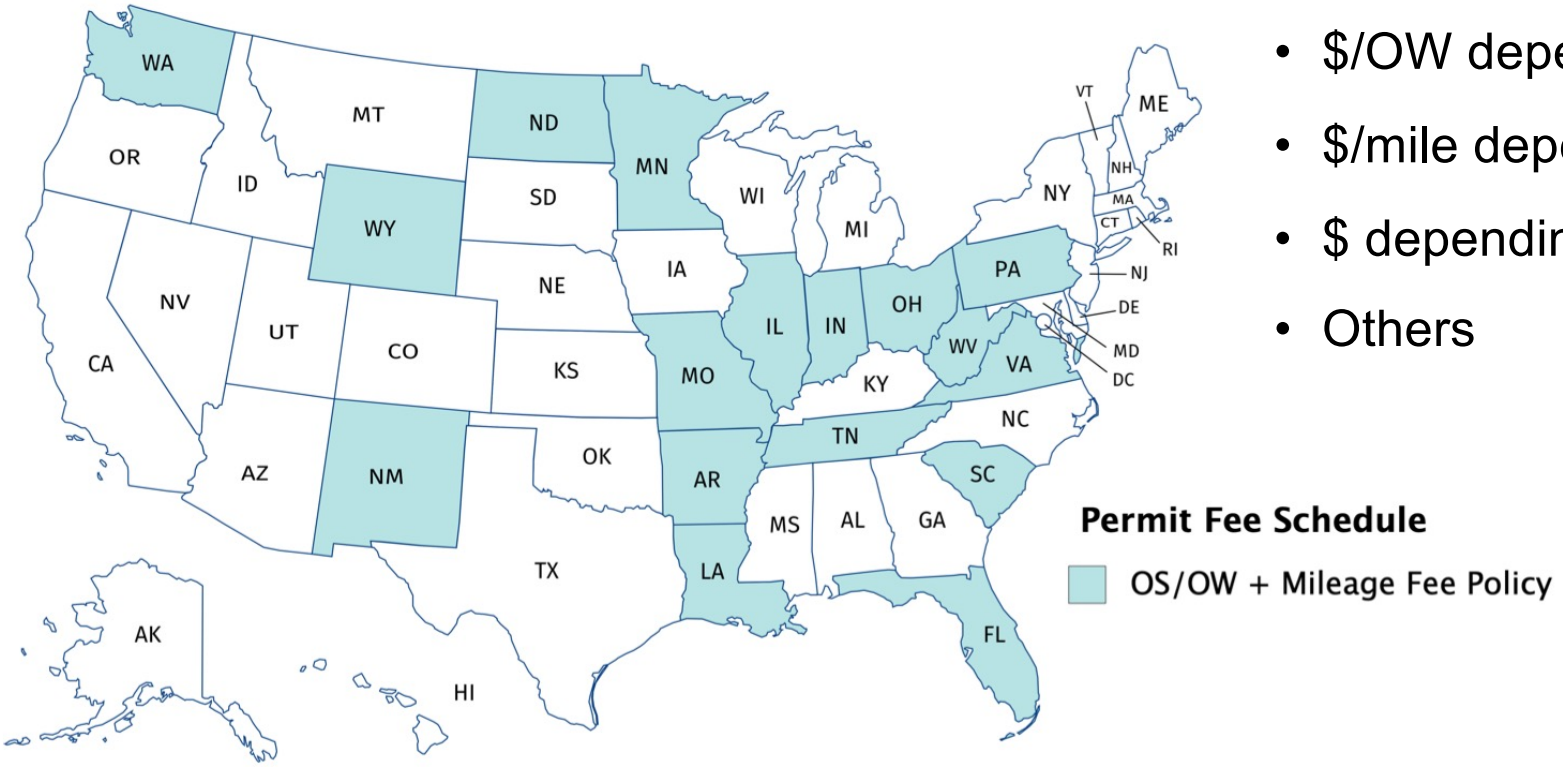
- OS/OW Fee State





Comparison of Permit Policies in the U.S.

- OS/OW/Mileage Fee State

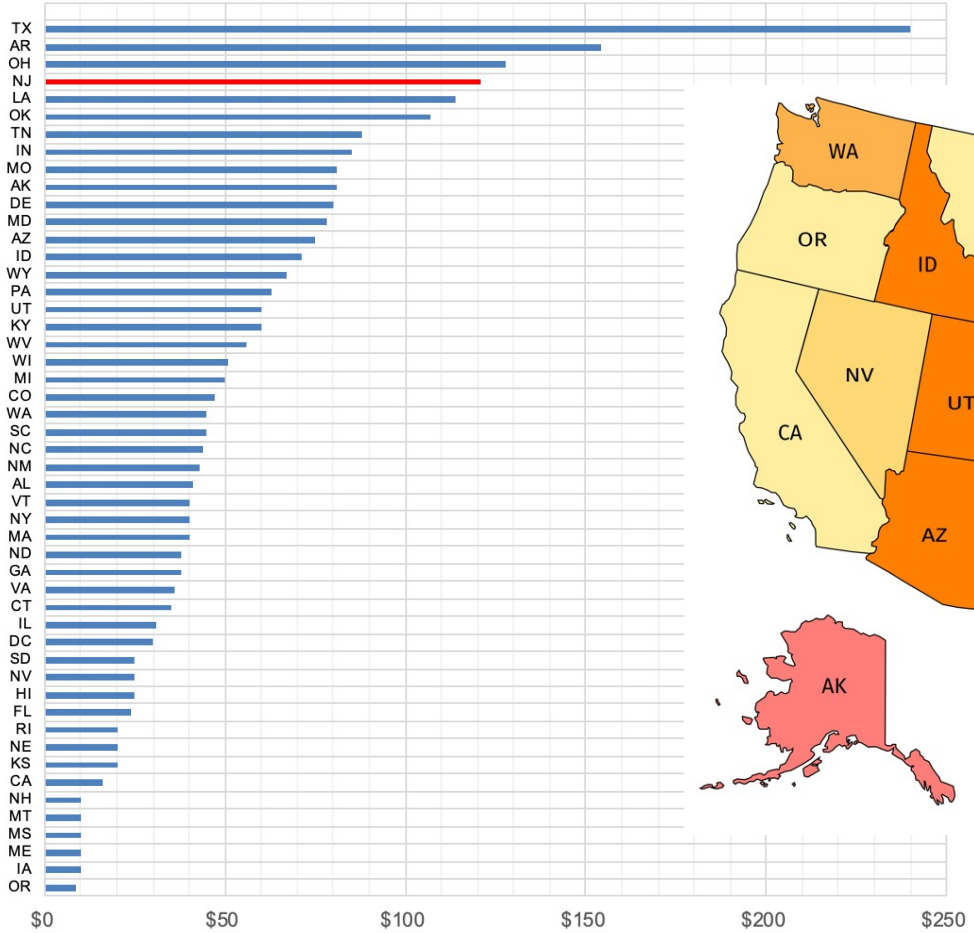


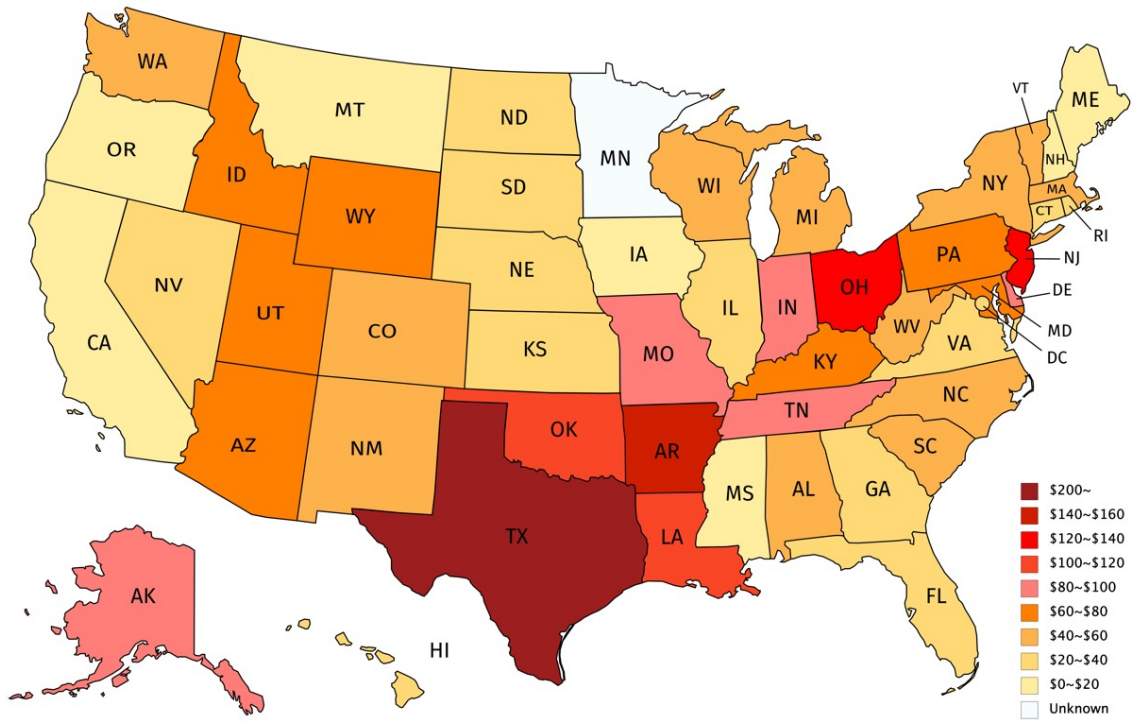
Fee Schedule Type:

- $/OW depending on mileage
- $/mile depending on OW
- $ depending on OW & mile
- Others

Comparison of Permit Policies in the U.S.

Average OW Permit Fee Map using NJ Permit Data





Alternative NJ OW Permit Policies

1. **Fee-based on Weight (Do Nothing):** It requires no update to the current program, and the agency and contractors can retain existing procedure.
2. **Add Mileage (In addition to the weight):** Permit trucks with shorter trip lengths traverse a shorter pavement segment and possibly over a fewer number of bridges than the permits with longer trip lengths (vice versa). Include a trip length component for a fairer OW permit fee policy for all vehicles.
3. **Flat Fee**: All the damage cost incurred is divided by the number of permits and the same flat fee is charged from all permit vehicles. Will reduce the administrative effort, however, it also has the harshest ramifications since the charged flat fee would be only fair for an average permit vehicle.

Conclusions

- For trucks paying permit OW tonnage fees (23% of all permits), the current NJDOT fee schedule recovers approximately 80% of damage cost on pavement and bridges incurred by the single trip OW permits.
- Code 23 truck permits pay the annual registration fee directly collected by DMV. No additional OW fee was collected by NJDOT to recover the damage caused to the infrastructure by these Code 23 trucks.
- Permit trucks using 6+ axles would cause less damage to the infrastructure.
- Using both NJ permit data applied to every state's permit fee schedule, the permit revenues were calculated. The current permit scheme in NJ is ranked as the fourth highest revenue among all states.

Recommendations

- It is recommended that OW tonnage fees for the single OW permit under Code 23 be applied. They induce damage to the bridges and pavements as the "paid" single OW permits; however, they do not contribute any revenues to recover the damaged infrastructure.
- It is recommended to provide incentives (i.e., lower permit fees) to promote using trucks with 6+ axles. The use of an additional axle would reduce the damage by 30% and two additional axles would even reduce the damage by 50% when the damage was compared to the typical Class 9 Truck (3S2 Truck).
- It is recommended to investigate various permit policies that would include mileage in addition of the OW tonnage fees.

Acknowledgement

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