

Level Crossing Crash Taxonomy for Connected Vehicle Safety Research

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**2014 Global Level Crossing
Safety and Trespass Prevention Symposium**
University of Illinois at Urbana-Champaign



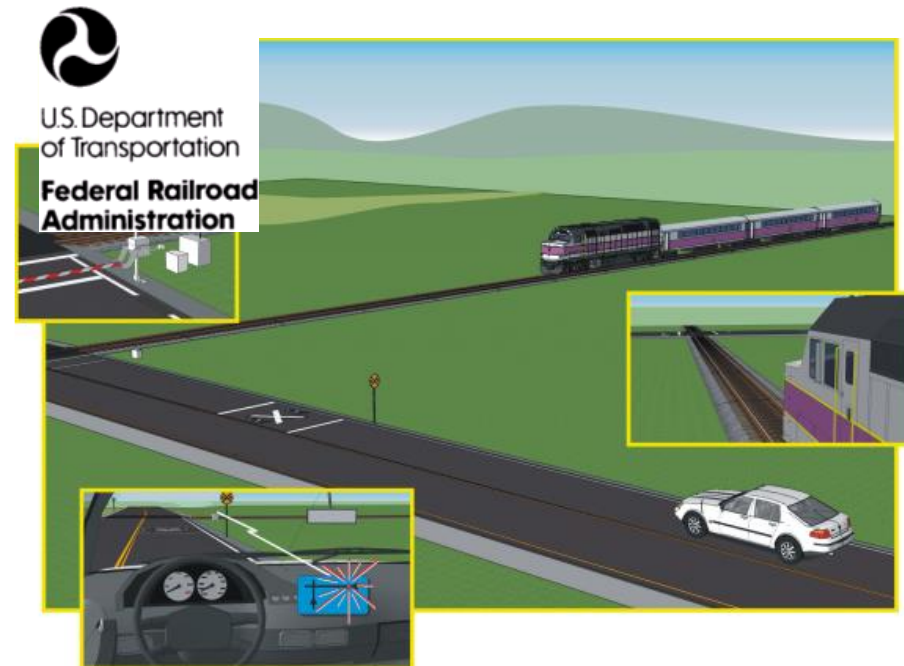
Introduction

□ Research sponsors

- US DOT Federal Railroad Administration Office of Research and Development
- US DOT Intelligent Transportation Systems Joint Program Office

□ Research Objective:

- Analyze FRA level crossing incident data from 2008-2012
- Estimate the economic and infrastructure costs associated with these incidents



Background

- ❑ Connected vehicle safety technology employs data radio transmission to reduce motor vehicle crashes
- ❑ These technologies potentially address up to 81% of crash scenarios involving unimpaired drivers
- ❑ This may result in the prevention of tens of thousands of automobile and truck crashes every year



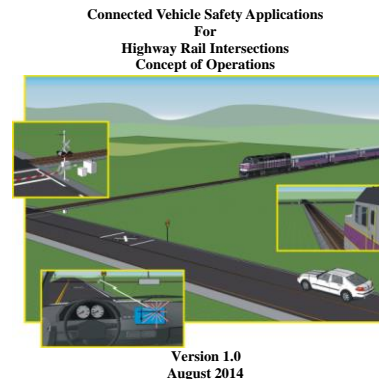
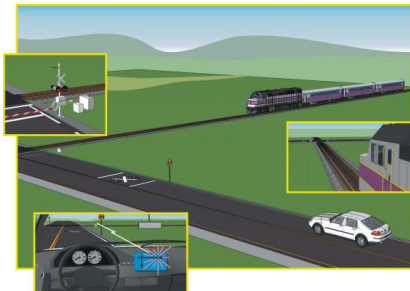
Level Crossing Connected Vehicle Research Overview

- ❑ Focus on level crossing-highway intersection
- ❑ Research products
 - Crash Taxonomy
 - Concept of Operations document
 - System requirements



**Highway-Rail Intersection Crash Taxonomy
For Connected Vehicle Safety Research**

Office of Research
and Development
Washington, DC 20590

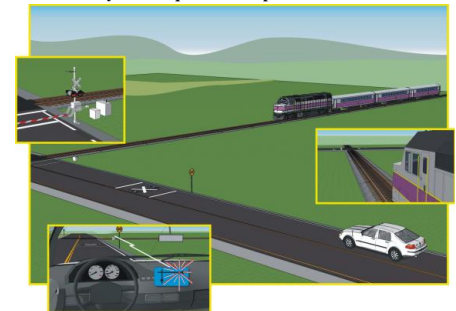


**Prepared for:
FRA Office of Research and Development**

**Prepared by:
John A. Volpe National Transportation Systems Center
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Systems Safety and Engineering Division**

The information in this document is based upon work supported by the Federal Railroad Administration (FRA). Any opinions, findings, and conclusions or recommendations expressed in this report are those of the author(s) and do not necessarily reflect the views of the FRA or U.S. Department of Transportation.

**Connected Vehicle Safety Applications
For
Highway Rail Intersections
System Requirements Specification**



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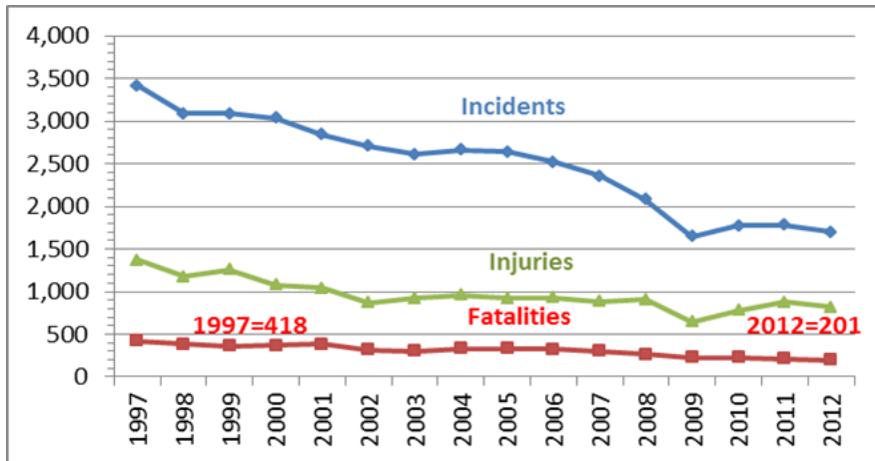
Crash Taxonomy Overview

- ❑ Taxonomy recommended by Connected Vehicle Advisory Team created in 2011
- ❑ Advisory Team composition
 - Rail
 - Transit
 - Highway
 - Motor Carrier
- ❑ Advisory Team recommended a 5-year data analysis
- ❑ Crash taxonomy is the foundation for the rest of the connected vehicle study

US Level Crossing Incident and Casualty Trends

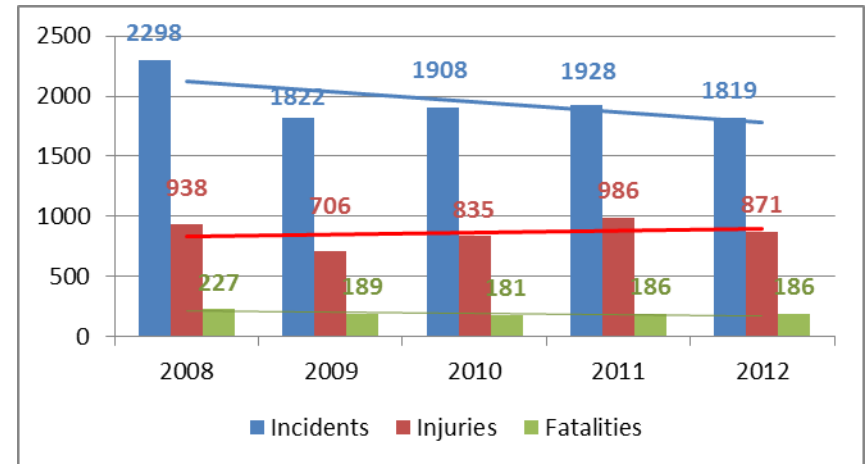
1997-2012

- ❑ Incidents: – 50.4%
- ❑ Injuries: - 44.3%
- ❑ Fatalities: - 39%



2008-2012

- ❑ Incidents: – 20.7%
- ❑ Injuries: - 24.7%
- ❑ Fatalities: - 16.7%

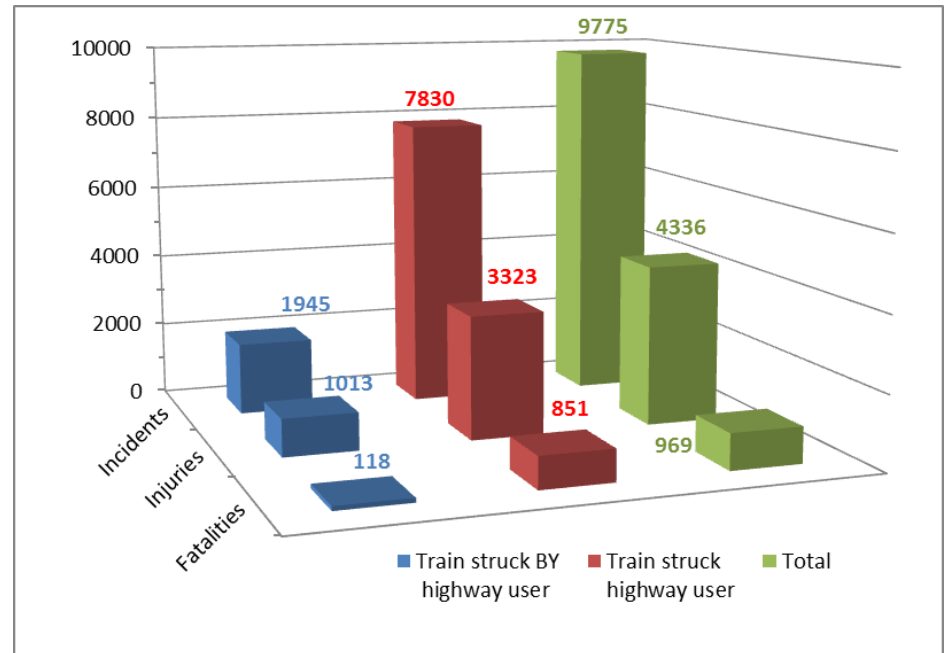


US Level Crossing Statistics 2008-2012

Year	Total Crossings	Incidents	Injuries	Fatalities
2008	219,758	2298	938	227
2009	217,479	1822	706	189
2010	211,708	1908	835	181
2011	209,991	1928	986	186
2012	210,315	1819	871	186
Totals		9775	4336	969

Crash Circumstances

- ❑ Train struck highway user
 - 80% of all incidents
 - 88% of all fatalities
- ❑ Train struck highway user was 80% more likely to result in a fatality as train struck by highway user



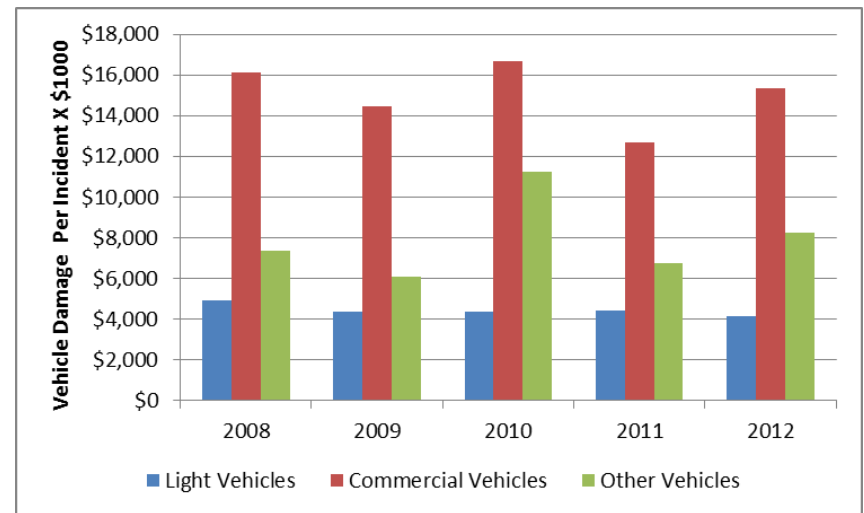
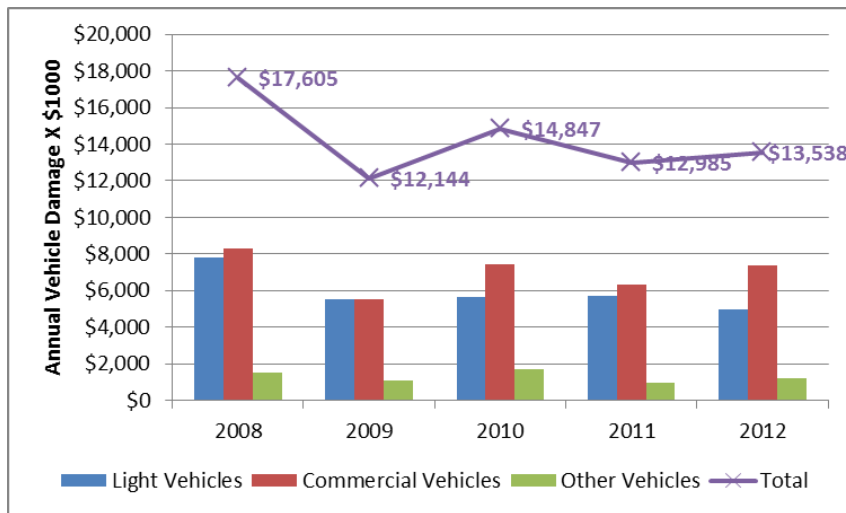
Motor Vehicle Accident Costs

- ❑ From FRA level crossing accident database
- ❑ Zero fatalities
 - 91.67% of all incidents
 - 89.2% of all injuries
 - 89.3% of all vehicle damage costs
- ❑ Average vehicle damage costs, on a per accident basis, was \$7,276

Total Fatalities Per Incident	Incidents	Injuries	Fatalities	Vehicle Damage
0	8961	3874	0	\$63,504,318
1	695	268	695	\$6,324,914
2	92	46	184	\$714,725
3	20	30	60	\$453,500
4	4	24	16	\$25,000
5	2	0	10	\$16,000
6	1	101	6	\$80,000
Total				\$71,118,457

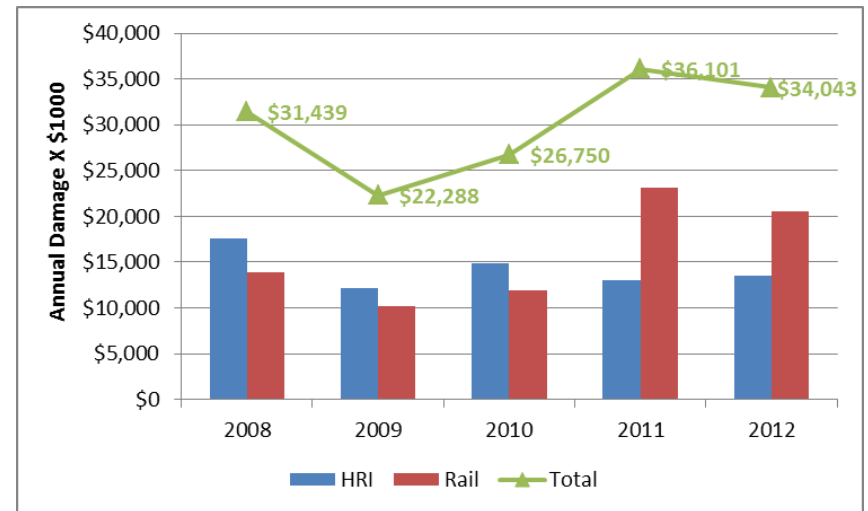
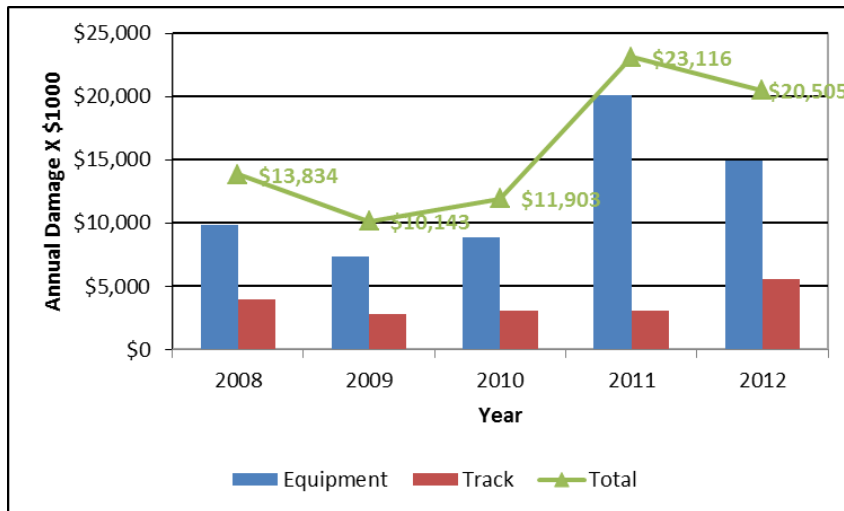
Motor Vehicle Accident Costs

- ❑ Annual total motor vehicle accident costs are trending lower
- ❑ Light and commercial vehicle accident costs are roughly equivalent
- ❑ However per accident commercial vehicle accident costs are 3-4 times higher than those of light vehicles



Rail Infrastructure Accident Costs

- ❑ Rail equipment accident costs are sensitive to low probability, high consequence events
- ❑ June 2010 accident = \$3.3 million
- ❑ June 2011 accident = \$8.5 million
- ❑ Losses to rail infrastructure have increased
- ❑ Motor vehicle damages have stabilized



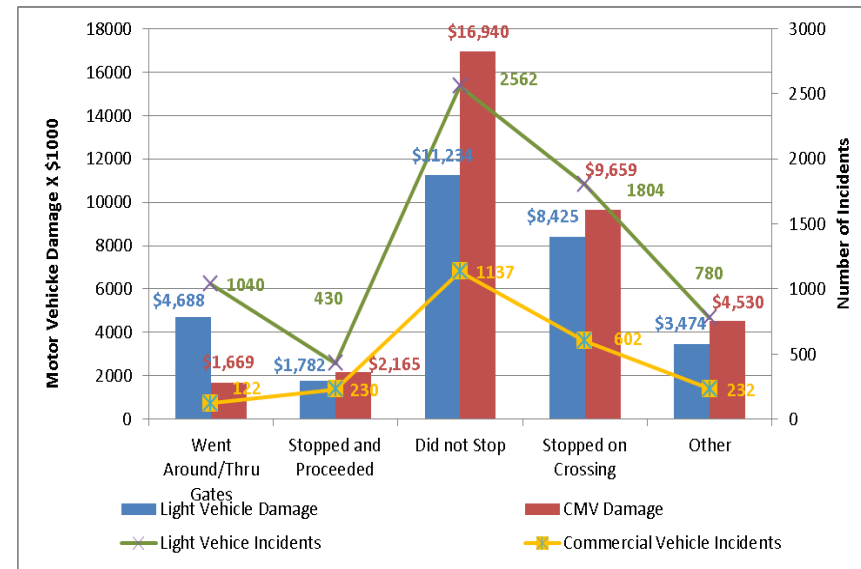
Accident Costs Related To Vehicle Violations: Light and Commercial Vehicles

❑ “Went Around/Thru Gates” violation type

- \$6.3 million (9.8%) of \$64.3 million cost
- Commercial vehicles: 121 (1.4%) of 8918 total incidents, but \$13,785/incident
- Light vehicles: 1040 (11.66%) of incidents, but \$4,448/incident

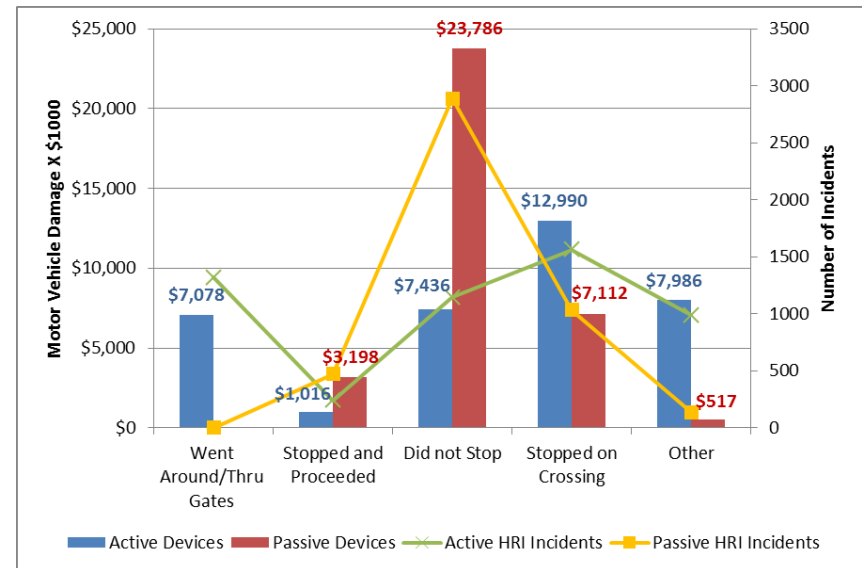
❑ “Did not Stop” violation type

- \$28.2 million (43.7%) of \$64.3 million cost
- 3696 (41.4%) of 8918 total incidents
- Commercial vehicles: 1134 (12.7%) of 8918 total incidents, but \$14,935/incident
- Light vehicles: 2562 (28.7%) of incidents, but \$4,383/incident



Accident Costs Related To Vehicle Violations: Active and Passive Crossings

- ❑ “Went Around/Thru Gates” violation type
 - 1231 (12.6%) of 9775 total incidents
 - \$6.5 million (9.4%) of \$71 million cost
 - All active at a cost of \$5,280/incident
- ❑ “Did not Stop” violation type
 - 4031 (41.2%) of 9775 total incidents
 - \$31.2 million (44%) of \$71 million cost
 - 2647 passive and 1144 active
 - Active: \$7.4 million or \$6,470/incident
 - Passive: \$23.8 million or \$9,000/incident

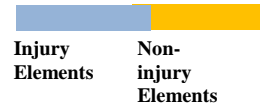


Direct Economic Cost Method

- ❑ FRA accident database does not account for injury severity or cost
- ❑ Direct Economic Cost Model
 - Used to estimate costs of Connected Vehicle preventable accidents*
 - Employs Maximum Abbreviate Injury Scale
 - Developed by the Association for the Advancement of Automotive Medicine

MAIS costs in 2009 dollars

Factor	PDO	MAIS 0	MAIS 1	MAIS 2	MAIS 3	MAIS 4	MAIS 5	Fatal
<i>Severity</i>	Property Damage Only	No Injuries	Minor	Moderate	Serious	Severe	Critical	Fatal
<i>Medical</i>	\$0	\$1	\$3,427	\$22,504	\$66,964	\$189,111	\$478,816	\$31,822
<i>EMS</i>	\$39	\$27	\$121	\$264	\$458	\$1,034	\$1,061	\$1,038
<i>Market Productivity</i>	\$0	\$0	\$2,324	\$33,246	\$94,959	\$141,452	\$583,016	\$791,199
<i>Household Productivity</i>	\$62	\$44	\$760	\$9,730	\$28,007	\$37,222	\$198,423	\$254,548
<i>Ins. Admin</i>	\$145	\$100	\$923	\$8,607	\$23,538	\$40,285	\$84,964	\$46,246
<i>Workplace</i>	\$68	\$45	\$335	\$2,595	\$5,670	\$6,243	\$10,886	\$11,565
<i>Legal</i>	\$0	\$0	\$187	\$6,206	\$19,695	\$41,967	\$99,490	\$127,250
<i>Travel Delay</i>	\$1,067	\$1,027	\$1,033	\$1,124	\$1,249	\$1,327	\$12,157	\$12,157
Property Damage	\$1,849	\$1,269	\$4,789	\$4,926	\$8,471	\$12,250	\$11,768	\$12,798
Total	\$3,230	\$2,514	\$13,899	\$89,202	\$249,011	\$470,891	\$1,480,581	\$1,288,623



*US DOT National Highway Traffic Safety Administration

Overall Harm To Society

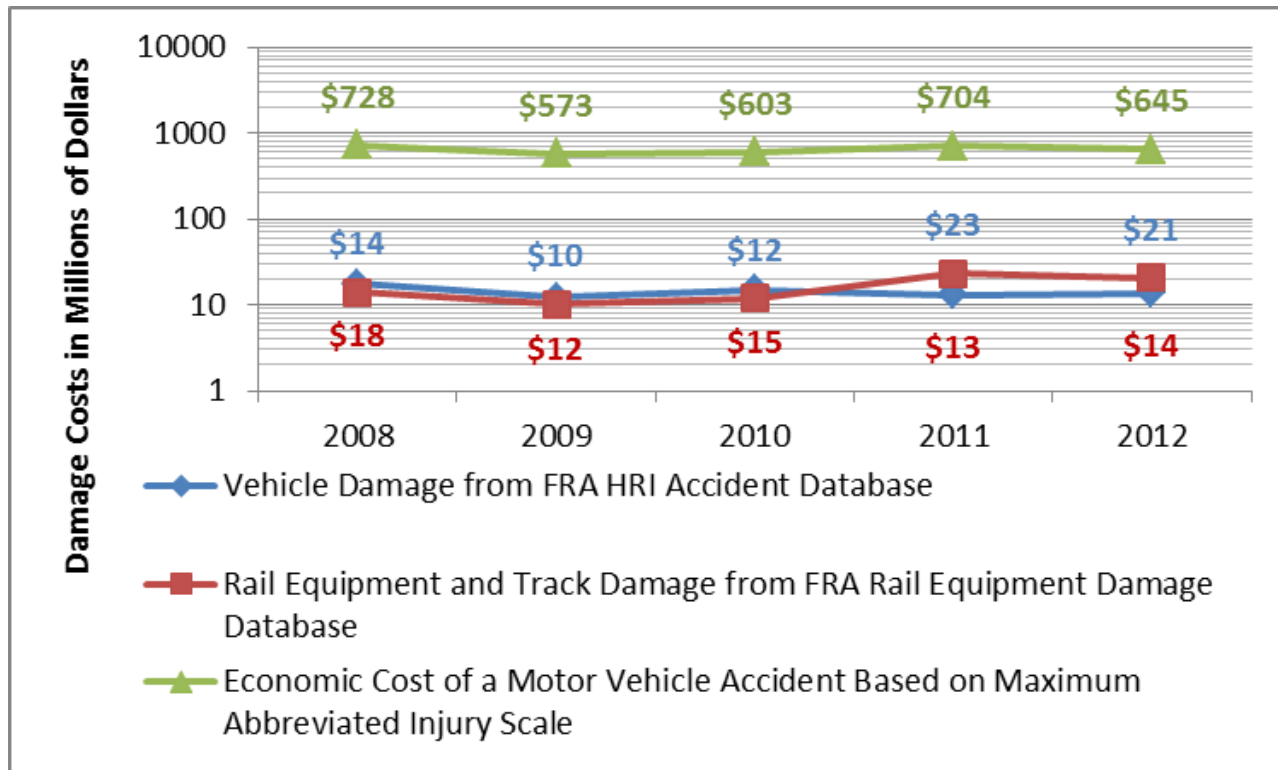
Year	Property Damage Only Accidents	No Vehicle Occupants Injured	Vehicle Occupant Injuries	Fatalities	Cost*	Functional* Years Lost
2008	314	1595	935	227	\$728,311,254	20,402
2009	252	1226	703	190	\$572,618,073	16,165
2010	249	1248	802	178	\$602,811,176	16,787
2011	244	1244	993	188	\$703,668,112	19,401
2012	277	1050	871	186	\$644,502,307	17,919
5- Year Average	268	1,273	861	194	\$650,382,184	18,135

*Calculated using MAIS Costs in 2009 Dollars

*Functional Years Lost is a non-monetary measure that sums the years of life lost to fatal injury and the years of functional capacity lost to nonfatal injury.

Comparison of Costs

- ❑ MAIS costs exceed combined motor vehicle and rail infrastructure damage costs by a factor of 20-25



Findings

- ❑ 2008 – 2012: level crossing incidents declined by around 20%
- ❑ Injuries and fatalities were relatively stable after 2009
- ❑ More than 50% of incidents occurred at active crossings
- ❑ Commercial vehicles
 - 20%-25% of the total
 - 45%-55% of the accident costs
- ❑ Societal harm costs
 - Average \$650 million
 - Range between \$250 million and \$1.5 billion
 - Exceed combined motor vehicle and rail damage costs by a factor of 20-25



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