



**NTSB** National Transportation Safety Board

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*Office of Highway Safety*

# Highway Factors

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# Introduction

- Crash test design standards
- Selection standards and guidelines
- Determination of standards
- Documents that contain standards and guidelines
- Integration of new designs

# Highway Information

- 85<sup>th</sup> Percentile speed was 72 mph
- Design speed and nighttime speed limit 65 mph
- Motorcoach traveling 68 mph
- U.S. 75 ADT was 46,961 vehicles/day
- ADT – northbound 21,000
- Commercial vehicles (16 percent)
- Bus ADT – 100 buses per day

30 inches wide



9 feet wide



# Bridge Design

- Bridge railing attached to 7-inch-high, 18-inch-wide curb
- Curbs no longer used on high-speed roads
- Bridge rail never crash-tested
- Superseded by modern designs

# View of Bridge Rail



# TL-4 Concrete Bridge Railing

No curbing

No curbing



# Crash Test Standards

- TL-3, Test Level Three: high-speed roadways with favorable site conditions
- TL-4, Test Level Four: high-speed, interstate highways with heavy vehicle mix
- TL-5, Test Level Five: significant number of heavy vehicles with unfavorable site conditions
- TL-6, Level Six: tanker-type trucks or similar high center of gravity vehicles with unfavorable site conditions

# Bridge Railing Test Levels

Vehicle Characteristics	Small Automobile		Pickup Truck	Single Unit Van Truck	Van-Type Tractor-Trailer		Tractor-Tanker Trailer
	<i>W</i> (kips)	1.55	1.8	4.5	18.0	50.0	80.0
<i>B</i> (ft.)	5.5	5.5	6.5	7.5	8.0	8.0	8.0
<i>G</i> (in.)	22	22	27	49	64	73	81
Crash Angle, $\theta$	20°	20°	25°	15°	15°	15°	15°
Test Level	Test Speeds (mph)						
TL-1	30	30	30	N/A	N/A	N/A	N/A
TL-2	45	45	45	N/A	N/A	N/A	N/A
TL-3	60	60	60	N/A	N/A	N/A	N/A
TL-4	60	60	60	50	N/A	N/A	N/A
TL-5	60	60	60	N/A	N/A	50	N/A
TL-6	60	60	60	N/A	N/A	N/A	50

# Test Level 5 Bridge Railing



Source: Federal Highway Administration

# Test Level 6 Bridge Railing



Source: Federal Highway Administration

# Crash Test Guideline Documents

- 1980-NCHRP 230 was published
- 1986-FHWA issued policy standard requiring TL-3 barriers on all NHS bridge railings
- 1994-NCHRP 350 updated NCHRP 230
- 2009-MASH updated NCHRP 350

# Guidance/Selection Documents

- 1989-AASHTO *Guide Specifications for Bridge Railings* provided selection levels or warrants
- 1994-*Load Resistance Factor Design (LRFD) Bridge Specifications*

# Areas Needing Improvement

- In 1994 AASHTO published the LRFD, which advised bridge owners to develop their own warrants
- Few states have done so
- New warrants are needed to define levels of heavy vehicle traffic and unfavorable site conditions

# Integration of New Designs

- Bridge railings designed to resist truck impacts impose higher deck loads
- Older bridge deck slabs are thinner and need individual engineering analysis before upgrades

# Conclusions

- A higher performance bridge railing such as a TL-4 or TL-5 at the accident location might have prevented the motorcoach's departure from the bridge
- Bridge owners lack warrants to guide them in making bridge railing selections

# Summary

- Crash testing of bridge rails developed over decades, will undergo continuous development
- Selection guidance or warrants have lagged and will be improved by recommendations



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