Session 23

Dean Alberson

Texas Transportation Institute/ Texas A&M Univ

Research Findings for LRFD Deck Design

Topic Description

FDOT and TxDOT jointly sponsored research into safety shaped bridge parapets on cantilevered decks. LRFD deck thickness requirements suggest current deck thicknesses used by FDOT might be inadequate. Research and crash tests don't support this notion.

Speaker Biography

Dean Alberson
Associate Research Engineer
Safety and Structural Systems Division, Crashworthy Structures Program (CEF)

Dr. Dean C. Alberson is an associate research engineer and program manager of the Crashworthy Structures Program with Texas Transportation Institute. He obtained his Ph.D. in Civil Engineering Structures at Texas A&M University. He originally came to TTI in 1992 to work with the Engineering Factors Program in the Safety Division. During that time, he was actively involved in the full-scale testing and evaluation of numerous highway safety features and was subsequently promoted to Program Manager of Engineering Factors. From 1996 to February of 2000, he was employed as a private consultant to several roadside safety hardware manufacturers. During this time, Dr. Alberson worked closely with manufacturers in the support of existing products, helped them improve their products, and developed new products. These tasks were accomplished through computer modeling, prototype tests, and full-scale developmental tests. Dr. Alberson is a registered professional engineer.

Research Findings for LRFD Deck Designs

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Special Projects Engineer
Texas Department of Transportation

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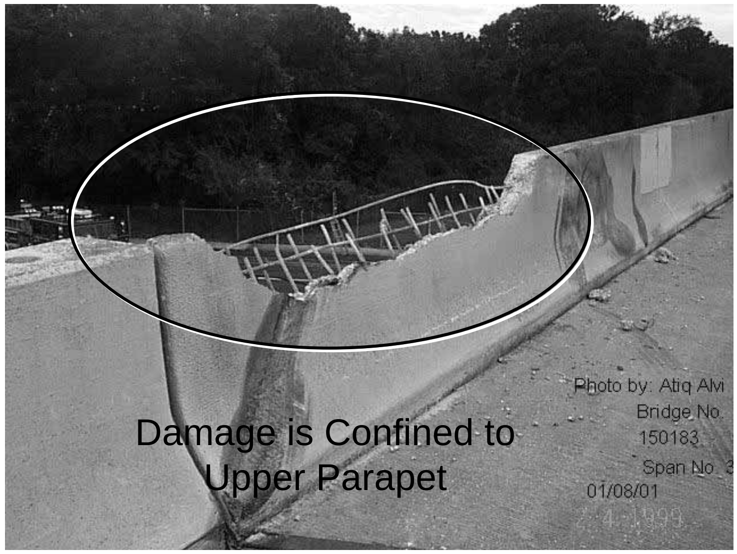
Dinosaur Bite?



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Looks Like a TL-4 Truck

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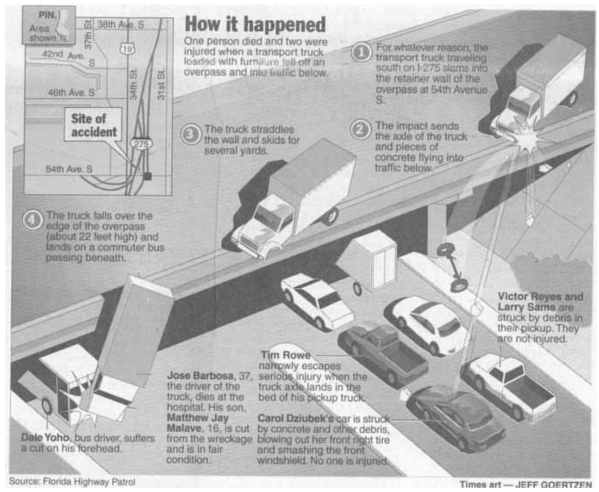
Newspaper Reconstruction



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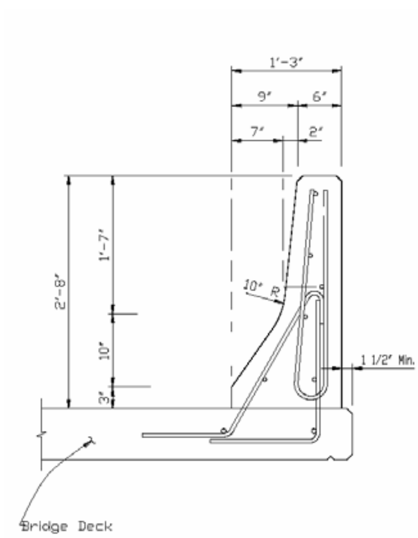
Typical FDOT Previous New Jersey Shape



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Current Typical Design

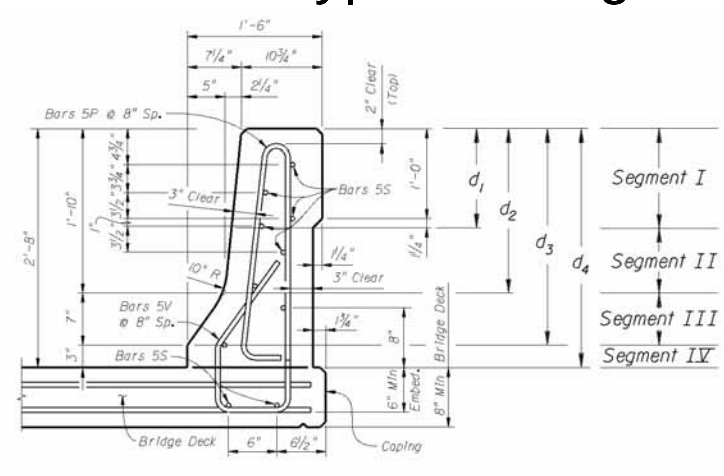

FIGURE I
TYPICAL SECTION THRU TRAFFIC RAILING BARRIER

AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

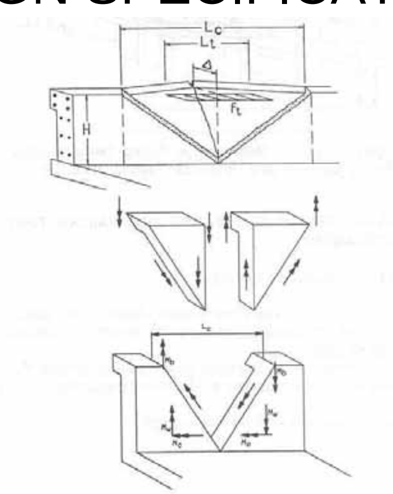

Figure CA13.3.1-1 - Yield Line Analysis of Concrete Parapet Walls for Impact within Wall Segment

AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

Table A13.2-1 - Design Forces for Traffic Railings

Design Forces and Designations	Railing Test Levels						
	TL-1	TL-2	TL-3	TL-4	TL-5A	TL-5	TL-6
F_t Transverse (KIP)	13.5	27	54	54	116	124	175
F_L Longitudinal (KIP)	4.5	9.0	18.0	18	39	41	58
F_v Vertical (KIP) Down	4.5	4.5	4.5	18	50	80	80
L_t and L_L (FT)	4.0	4.0	4.0	3.5	8.0	8.0	8.0
L_v (FT)	18.0	18.0	18.0	18.0	40.0	40.0	40.0
H_e (min) (IN)	18	20	24	32	40	42	56
Minimum H Height of Rail (IN)	27	27	27	32	40	54	90

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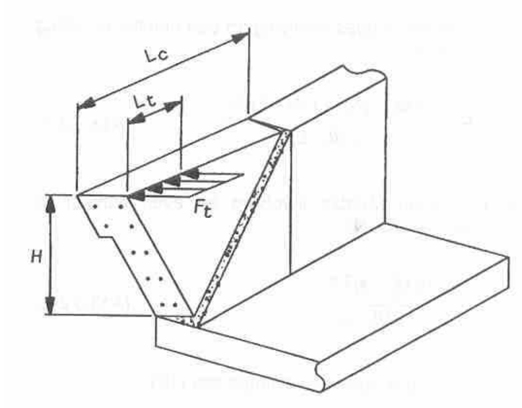

Figure CA13.3.1-2 - Yield Line Analysis of Concrete Parapet Walls for Impact Near End of Wall Segment

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Computed Parapet Strengths

- Transverse Load @ Joint (Single Yield Line)
  - 41.5 kips
- Transverse Load @ Mid-span (Dual Yield)
  - 62.1 kips

*Failure is assumed to occur in upper slender portion of parapet.

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TL-4 Impact @ Joint

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TL-4 Impact

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TL-4 Impact

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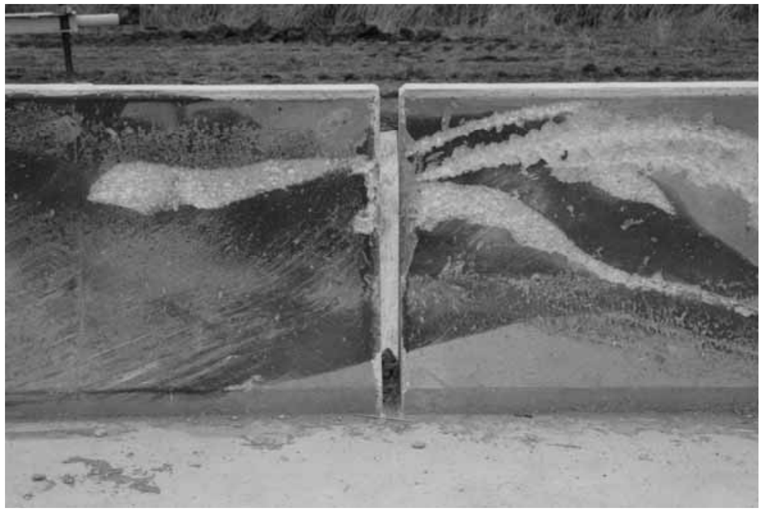
Installation After TL-4 Impact



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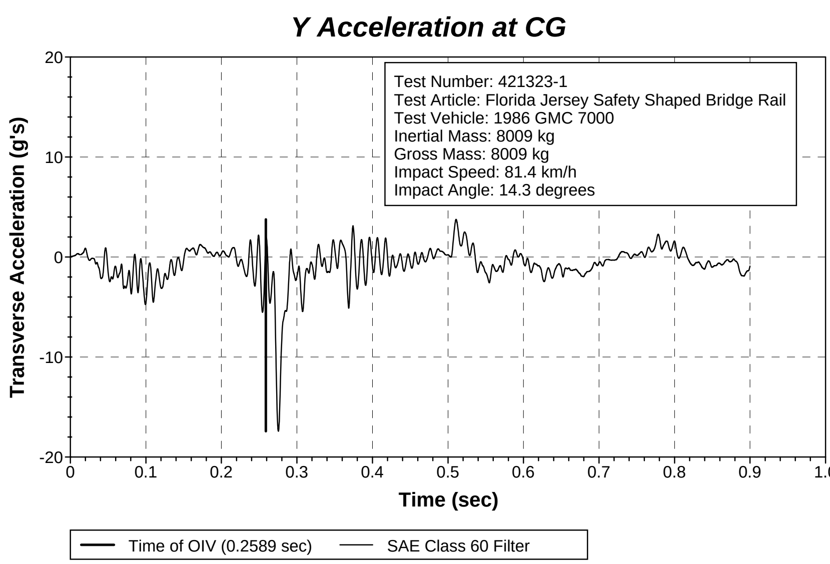

50 ms 4.9 g's

Accelerometer on Frame

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TL-3 Impact @ Joint

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TL-3 Impact

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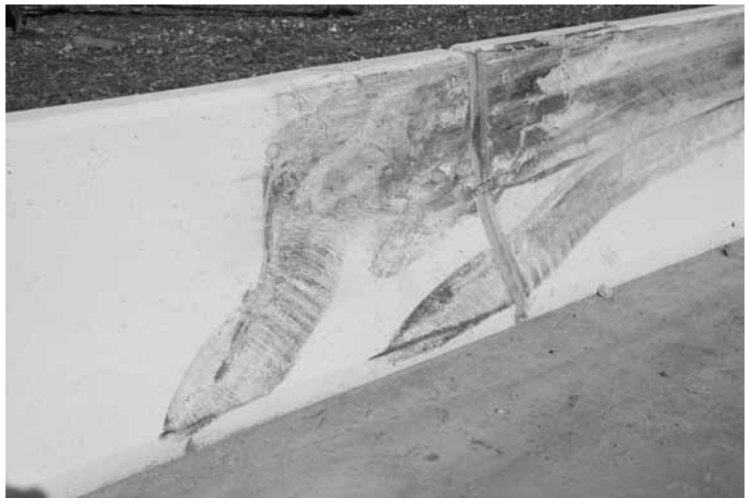
Installation After TL-3 Impact



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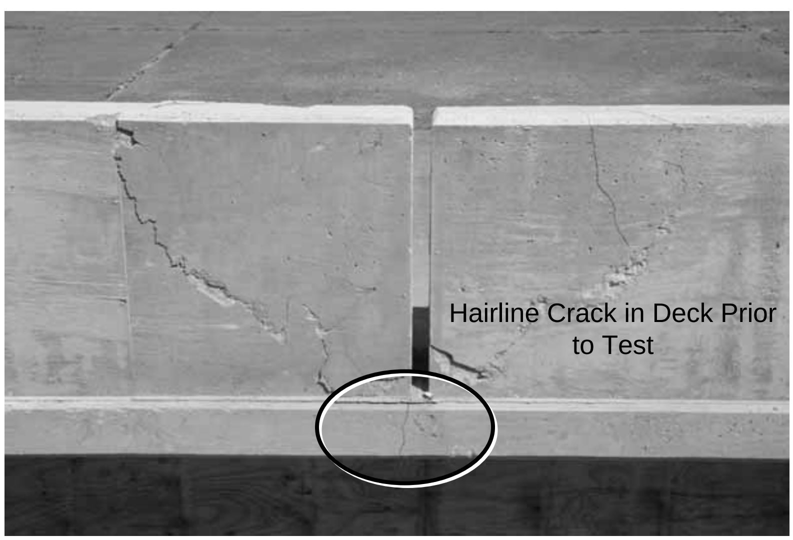
Installation After TL-3 Impact



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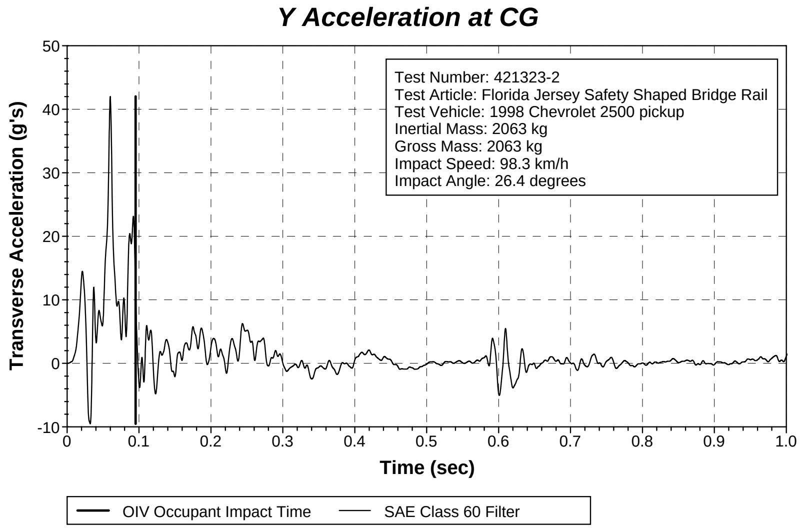

50 ms 15.3 g's -- 67,450 lbs

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Static Load Testing

- Simulated AASHTO LRFD Chapter 13 Loading
- Tested at the Joint
- Tested at Mid-Span
- Tested at TL-4 Impact Point
  - After Test (Any damage to parapet not visible?)

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Test Apparatus

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Test Apparatus @ Joint

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Testing @ Joint

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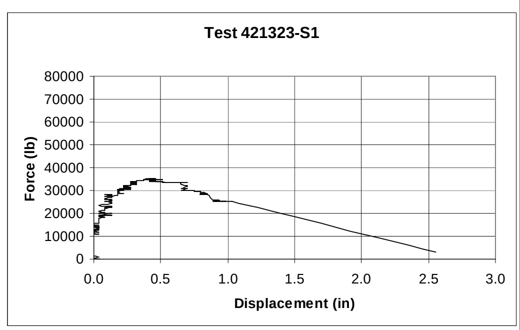
Post Test Damage @ Joint

Maximum Load 35,100 lb*

Computed Load 41,500 lb



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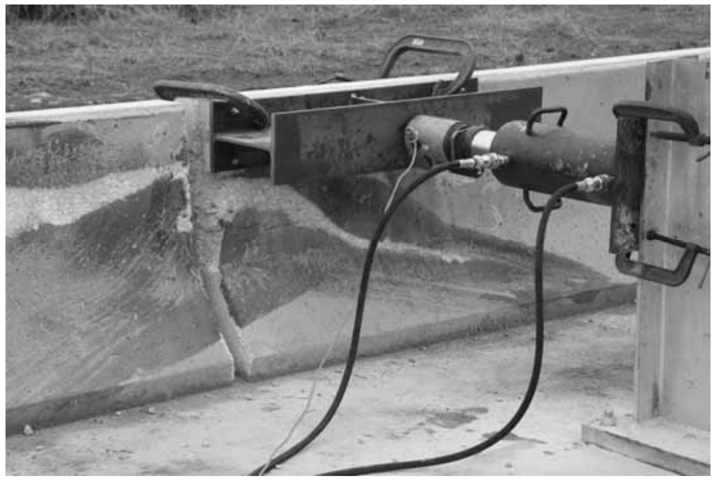
Post Test Damage @ TL-4 Joint



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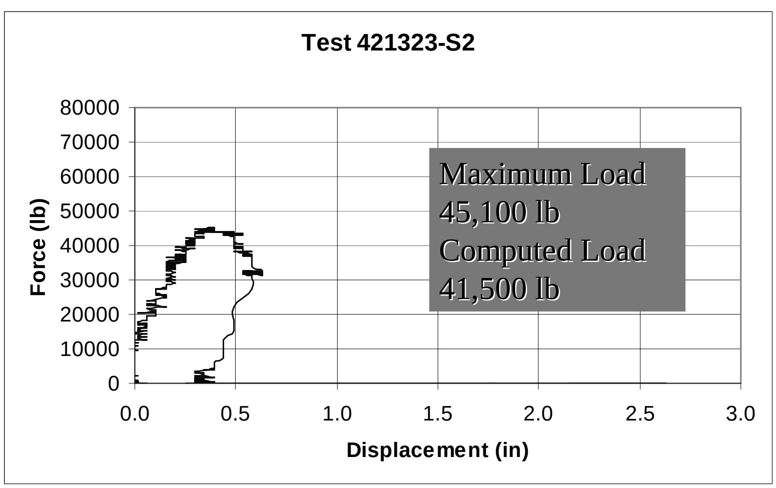
Post Test Loading @ TL-4 Joint



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Testing @ Mid-Span

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Break @ Mid-Span

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Damage @ Mid-Span

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Isolated in Parapet

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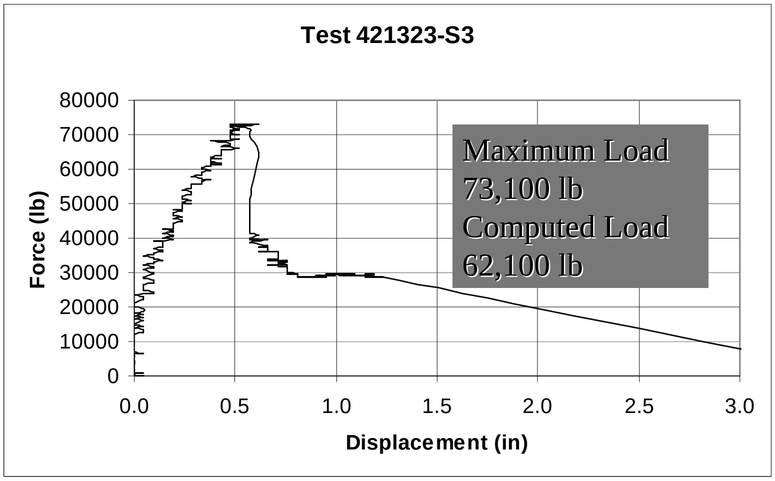
Loading @ Mid-Span



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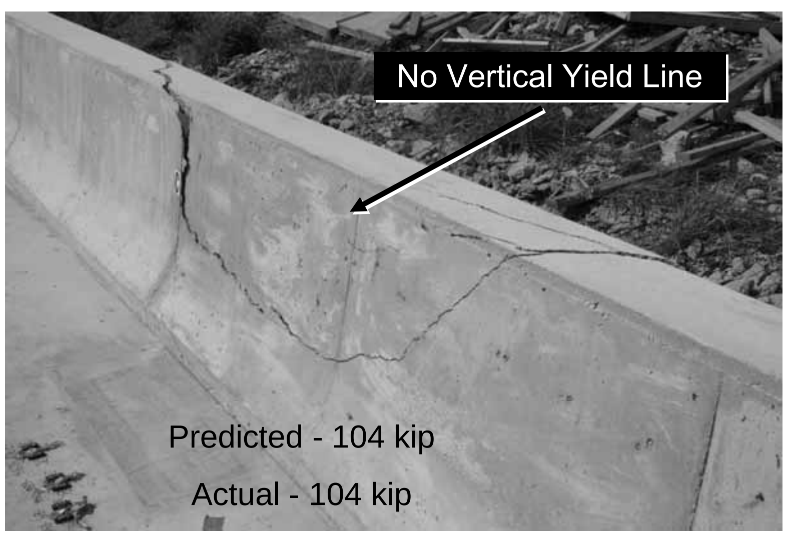
Mid-Span Current Design



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Mid-Span Current Design

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Mid-Span Current Design

Crack Propagation into Deck

104 kips !

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End-Span Current Design

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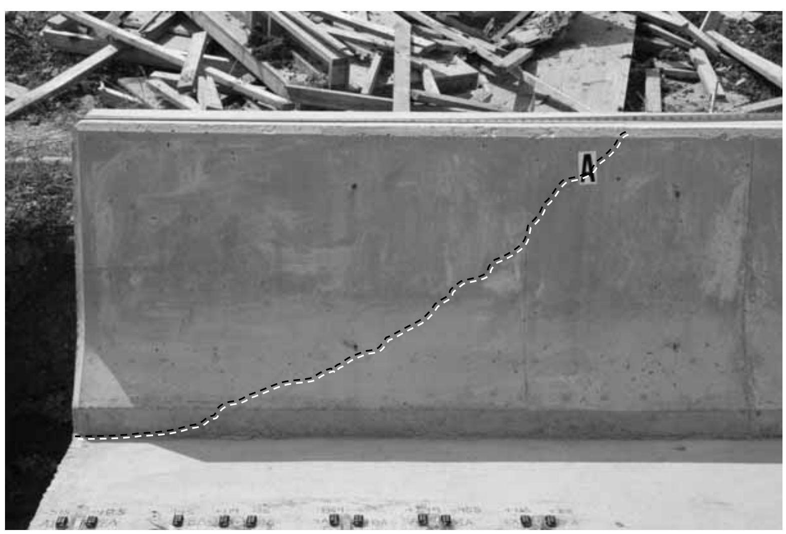
End-Span Current Design



73 kip Predicted -- 64 kip Failure

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End-Span Current Design

Deck Damage

at 64 kip

at End Segment

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Summary

- The minimally reinforced FDOT 32 inch New Jersey Shape Bridge Parapet successfully contained vehicles to TL-4.
- Damage from the TL-3 test was isolated in the parapet.
- The predicted static capacity of the parapet closely matched the actual values.
- Parapet damage in the TL-4 test was cosmetic only and was verified by the “post” test static loading.
- The TL-3 pickup test caused more damage to the parapet than the TL-4 single unit truck.

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Summary

- At center span load applications to failure in the parapet, the center vertical yield line was never produced.
- Further review of the damaged zones showed 45 degree shear planes from the load application region.
- Punching shear may be a more appropriate method of analysis for center span failure of strong concrete parapets.

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Conclusions

1. Previous Jersey Shaped Parapet Design is Still Adequate to TL-4.
2. Minimal Chance for Deck Damage with Previous Design.
3. Current F-Shape Significant Strength Increase.
4. Chance for Deck Damage Only When Severely Overloaded.
5. Punching Shear may be better Design Method for Mid-Span Design.

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Questions?

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