Update on Guidelines for the Selection of Cable Barrier Systems, NCHRP Project 20-7(210)

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Objectives of the Study

• Develop Guidelines for the Selection of Cable Barrier Systems.

– State of the Practice Review of Cable Barrier Systems in the US and Abroad
  • Literature Review
  • Conduct Survey
Current Wire Rope Systems in U.S.

• U.S. Generic Low Tension (New York)
• High Tension
  – Safence
  – Brifen (Wire Rope Safety Fence-WRSF)
  – Gibralter (Cable Barrier System)
  – Nucor Marion (U. S. High Tension)
  – Trinity (Cable Safety System-CASS)
U.S. Generic Low Tension

- Hook Bolt
- S75 X 8.5 X 1.6 m
- 120 mm
- 770 mm
- 50 mm
- 120 mm
- Wire rope
Safence

http://www.safence.com
Nucor Steel Marion

http://www.nsmarion.com
http://www.gsihighway.com
Trinity Industries

http://www.highwayguardrail.com
States Responding to Survey

- Responding States
- Non-Responding State
Survey Respondents Cable Barrier Use by State
When is placement of a median cable barrier considered in your state?

- New construction, 17%
- Reconstruction, 16%
- Response to crash history, 24%
- System-wide policy to implement barrier, 15%
- Political, 8%
- Resurfacing/Restoration/Rehabilitation, 11%
- Other, 7%
Other (7%) 

- We do not have any median cable rail used in Montana.
- UW-Madison TOPS Lab Report of June 2005 identified several freeway segments requiring median barrier protection.
- No history.
- As proactive safety measure.
- System-wide policy if for the replacement of w-beam guardrail encirclements around median bridge piers.
- Experiment to improve safety and reduce maintenance costs.
How does the agency decide when a median cable barrier is warranted?

- Crash history, 32%
- Cross section, traffic, alignment, etc., 27%
- Case-by-case, 20%
- Across the board policy, 8%
- Other, 13%
Other (13%)

- N/A (2)
- Aesthetic concerns.
- UW-Madison TOPS Lab Report of June 2005 identified several freeway segments requiring median barrier protection.
- Warrants are still in development.
- Currently writing policy, will state, in essence, that cable rail is appropriate to use as long as there is sufficient room for deflection.
- Selection is based on guidelines published in the Departments Road Design Manual, Page A-30.
- We are currently in the “test project” phase in the state (Georgia) with state-wide (interstate) a possibility.
- System-wide policy if for the replacement of w-beam guardrail encirclements around median bridge piers.
High Tension Cable Barrier Systems

• Has your state installed any of the high tension cable barrier systems?
  – 28 of 29 states responded
    • Yes  82% (23 of 28)
    • No   18% (5 of 28)

• Are the cables prestretched?
  • Yes  100%
Which high-tension cable barrier systems has your state installed?

- Trinity Industries, 38%
- Nucor Steel Marion, 10%
- Gibraltar, 10%
- Blue Systems, 5%
- Brifen USA, 37%
Approximate Number of Miles

<table>
<thead>
<tr>
<th>Company</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safence</td>
<td>4.0</td>
</tr>
<tr>
<td>Brifen</td>
<td>287.0</td>
</tr>
<tr>
<td>Gibraltar</td>
<td>195.0</td>
</tr>
<tr>
<td>Nucor Steel Marion</td>
<td>220.5</td>
</tr>
<tr>
<td>Trinity Industries</td>
<td>340.5</td>
</tr>
<tr>
<td><strong>Total Miles Installed</strong></td>
<td><strong>1047</strong></td>
</tr>
</tbody>
</table>
What is the approximate number of miles in place or expected to be in place by the end of 2006?
What is the approximate number of miles in place or expected to be in place by the end of 2006?

- Low-Tension: 1000 miles
- High-Tension: 700 miles
What other safety treatments are employed by your state in conjunction with the cable barrier?

- Shoulder rumble strips, 44%
- Delineators, 39%
- None, 10%
- Others, 7%
Other (7%)

• Shoulder widening.
• Standard guardrail.
• Sand barrels.
Background

- Why was the 70 feet or less median width significant (cntd.)?
  - There was no correlation to speed, median width, volume, time of day, or weather conditions for Across Median Crashes
  - Potential to eliminate approximately 95 percent of all Across Median Crashes

*State of North Carolina “AASHTO TIG-CMP”*
Median Barrier Benefits

- Effect on Fatal Crashes and Fatalities (contd.)
  - Estimated 59 Fatal Across Median Crashes have been avoided and 96 lives saved from January 1999 to December 2003
  - Results in crash costs savings of more than $205 million in fatal crash cost alone
  - Across Median Fatal Crashes (5 Years Before to After)
    
    |             | Before | After | Percent (+/-) |
    |-------------|--------|-------|--------------|
    | Fatal Crashes | 133    | 79    | - 40.6 %     |
    | Fatalities    | 198    | 104   | - 47.5 %     |

*State of North Carolina “AASHTO TIG-CMP”*
### Median Barrier Benefits

- Long Term Median Barrier Evaluation (cntd.)

<table>
<thead>
<tr>
<th>MEDIAN BARRIER CRASH DATA (All Barrier Types)</th>
<th>Before</th>
<th>Crashes</th>
<th>After</th>
<th>Crashes</th>
<th>Percent (+/-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average # of Years in Crash Analyses</td>
<td>6.27</td>
<td>3.56</td>
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<tr>
<td>Average ADT within the Sections</td>
<td>29,100</td>
<td>37,300</td>
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<tr>
<td>Number of Total Crashes</td>
<td>13,298</td>
<td>1,964</td>
<td>12,080</td>
<td>3,393</td>
<td>72.8</td>
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<tr>
<td>Number of Fatal Crashes</td>
<td>194</td>
<td>29</td>
<td>95</td>
<td>27</td>
<td>-6.9</td>
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<tr>
<td>Number of A Injury Crashes</td>
<td>578</td>
<td>85</td>
<td>224</td>
<td>63</td>
<td>-26.3</td>
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<tr>
<td>Number of B &amp; C Injury Crashes</td>
<td>4,509</td>
<td>666</td>
<td>3,646</td>
<td>1024</td>
<td>53.8</td>
</tr>
<tr>
<td>Number of PDO Crashes</td>
<td>8,017</td>
<td>1,184</td>
<td>8,115</td>
<td>2,279</td>
<td>92.5</td>
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<tr>
<td>Number of Total X-Median Crashes</td>
<td>1070</td>
<td>136</td>
<td>114</td>
<td>52</td>
<td>-79.7</td>
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<tr>
<td>Number of Total Fatal Crashes</td>
<td>80</td>
<td>12</td>
<td>6</td>
<td>2</td>
<td>-85.7</td>
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<tr>
<td>Number of Total Median Barrier Hits</td>
<td>na</td>
<td>na</td>
<td>3,922</td>
<td>1,102</td>
<td>100.0</td>
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<tr>
<td>Percentage of Total</td>
<td>na</td>
<td>na</td>
<td>32.5%</td>
<td></td>
<td></td>
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<tr>
<td>Number of Total Median Barrier Breaching</td>
<td>na</td>
<td>na</td>
<td>110</td>
<td>31</td>
<td>100.0</td>
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<tr>
<td>Percentage of Total</td>
<td>na</td>
<td>na</td>
<td>2.8%</td>
<td></td>
<td></td>
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</tbody>
</table>

*State of North Carolina “AASHTO TIG-CMP”*
NC Cross-median Crashes

![Graph showing the relationship between average daily traffic (vehicle/day) and median width (feet) with labels for barrier options and evaluation need for barrier.]

- Barrier Option
- Barrier Not Normally Considered
- Evaluate Need for Barrier
## Continued Evaluation Efforts
### I-40 -- McDowell County (W-Beam)

<table>
<thead>
<tr>
<th></th>
<th>Before Period</th>
<th>Construction Period</th>
<th>After Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Range</td>
<td>1/1/92 – 2/28/99</td>
<td>3/1/99 – 11/30/99</td>
<td>12/1/99 – 6/30/02</td>
</tr>
<tr>
<td>Number of Years</td>
<td>7.17</td>
<td>0.75</td>
<td>2.58</td>
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<tr>
<td>Median ADT</td>
<td>23,900</td>
<td>26,000</td>
<td>24,800</td>
</tr>
<tr>
<td>Total Number of Crashes</td>
<td>354</td>
<td>38</td>
<td>145</td>
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<tr>
<td><strong>Severity Index</strong></td>
<td><strong>9.68</strong></td>
<td><strong>7.72</strong></td>
<td><strong>4.65</strong></td>
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<tr>
<td>Total Number of Fatal Crashes</td>
<td>7</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Number of Across Median Crashes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number of Fatal Across Median Crashes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Median Barrier Hits</td>
<td>N/A</td>
<td>16</td>
<td>38</td>
</tr>
<tr>
<td>Number of Across Median, Barrier Breaching Crashes</td>
<td>N/A</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Across Median, Barrier Breaching Crashes/Median Barrier Hit Percentage</td>
<td>N/A</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

*North Carolina – “Continuing to Save Lives by Preventing Across Median Crashes” Brochure (December 2002)
Emergency Crossovers

- The local emergency services and law enforcement complained at first, but now we are getting positive feedback from them after they see how effective this system is in eliminating the crossover accidents.
- Utilizing the overpass locations to switch sides with the wire fence.
- Serves as a location where emergency vehicles can change direction since there is sufficient room between the columns and the wire fence.

*Illinois “AASHTO TIG-CMP”*
# Multiplying Factors for Barrier Design Deflections

<table>
<thead>
<tr>
<th>Barrier Length (meters)</th>
<th>0°</th>
<th>0.5°</th>
<th>1°</th>
<th>1.5°</th>
<th>2°</th>
<th>2.5°</th>
<th>3°</th>
<th>3.5°</th>
<th>4°</th>
</tr>
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<tbody>
<tr>
<td>30</td>
<td>0.85</td>
<td>0.88</td>
<td>0.91</td>
<td>0.91</td>
<td>0.93</td>
<td>0.95</td>
<td>0.97</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>0.96</td>
<td>0.98</td>
<td>1.05</td>
<td>1.08</td>
<td>1.12</td>
<td>1.17</td>
<td>1.21</td>
<td>1.26</td>
<td></td>
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<tr>
<td>90</td>
<td>1.00</td>
<td>1.06</td>
<td>1.11</td>
<td>1.14</td>
<td>1.17</td>
<td>1.23</td>
<td>1.28</td>
<td>1.33</td>
<td>1.39</td>
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<tr>
<td>120</td>
<td>1.08</td>
<td>1.11</td>
<td>1.17</td>
<td>1.21</td>
<td>1.29</td>
<td>1.32</td>
<td>1.35</td>
<td>1.48</td>
<td>1.55</td>
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<tr>
<td>150</td>
<td>1.11</td>
<td>1.16</td>
<td>1.20</td>
<td>1.25</td>
<td>1.34</td>
<td>1.38</td>
<td>1.49</td>
<td>1.56</td>
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<tr>
<td>180</td>
<td>1.14</td>
<td>1.19</td>
<td>1.25</td>
<td>1.30</td>
<td>1.38</td>
<td>1.49</td>
<td>1.57</td>
<td>1.69</td>
<td>1.77</td>
</tr>
<tr>
<td>210</td>
<td>1.17</td>
<td>1.20</td>
<td>1.28</td>
<td>1.38</td>
<td>1.46</td>
<td>1.53</td>
<td>1.66</td>
<td>1.74</td>
<td>1.84</td>
</tr>
<tr>
<td>240</td>
<td>1.18</td>
<td>1.21</td>
<td>1.35</td>
<td>1.42</td>
<td>1.50</td>
<td>1.57</td>
<td>1.70</td>
<td>1.80</td>
<td>1.91</td>
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<tr>
<td>270</td>
<td>1.18</td>
<td>1.28</td>
<td>1.35</td>
<td>1.43</td>
<td>1.51</td>
<td>1.62</td>
<td>1.75</td>
<td>1.84</td>
<td>1.98</td>
</tr>
<tr>
<td>300</td>
<td>1.18</td>
<td>1.29</td>
<td>1.37</td>
<td>1.45</td>
<td>1.57</td>
<td>1.67</td>
<td>1.77</td>
<td>1.88</td>
<td>2.12</td>
</tr>
<tr>
<td>330</td>
<td>1.18</td>
<td>1.30</td>
<td>1.37</td>
<td>1.46</td>
<td>1.59</td>
<td>1.71</td>
<td>1.81</td>
<td>1.95</td>
<td>2.18</td>
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<tr>
<td>360</td>
<td>1.19</td>
<td>1.30</td>
<td>1.39</td>
<td>1.48</td>
<td>1.62</td>
<td>1.74</td>
<td>1.86</td>
<td>2.01</td>
<td>2.24</td>
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<td>390</td>
<td>1.19</td>
<td>1.30</td>
<td>1.39</td>
<td>1.49</td>
<td>1.64</td>
<td>1.76</td>
<td>1.90</td>
<td>2.07</td>
<td>2.42</td>
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<tr>
<td>420</td>
<td>1.19</td>
<td>1.30</td>
<td>1.41</td>
<td>1.50</td>
<td>1.66</td>
<td>1.80</td>
<td>1.95</td>
<td>2.23</td>
<td>2.50</td>
</tr>
<tr>
<td>450</td>
<td>1.19</td>
<td>1.30</td>
<td>1.43</td>
<td>1.56</td>
<td>1.69</td>
<td>1.83</td>
<td>2.00</td>
<td>2.26</td>
<td>2.54</td>
</tr>
</tbody>
</table>

Note: Baseline for design deflections is a 90 m barrier length with no curvature.

*Cable And Wire Rope Barrier Design Considerations: Review, Alberson-DC; Bligh-RP; Buth-CE; Bullard-DL Jr., Transportation Research Record No. 1851*
Cable Barrier Features

- Aesthetic
- Low snow drift
- Low occupant risk/longer deflections
- Low initial cost
- Ease of repair
- Ease of inspection
- Some secondary capacity
- No “Back” side
Cable Barrier Issues

• Horizontal curvature (inside/outside)
• Vertical alignment (Under-ride)
• Lateral placement (2 items)
  – Impact frequency
  – Bottom Ditch (erosion & anchorage – 4 ft offset)
• On slopes
  – how much slope and where can we put it
• Pre-Stretch vs. Non Pre-stretch
  – Maintenance first Year
• Cable and post interaction connection strength
• Tension – Temperature - Modulus of Elasticity
• Post spacing and effect on performance
• Sources of tension loss
Vehicles on Slopes

Truck Heights

Car Heights

Texas Transportation Institute
Cable Barrier Issues

- Cable heights (top/bottom and tolerance)
- Soil, footings, post embedment
- Installation length between anchors
- Low tension compensators
- Temperature - ambient vs. rope temperature
- Field applied vs. factory applied fittings
- Small car on TL-4 (top cable may be a problem – may need more cables)
- Higher encroachment angles (may likely exceed capacity)
- Others?
Cable Barrier Websites:

- FHWA = http://www.safety.fhwa.dot.gov/roadway_dept/road_hardware/longbarriers.htm
- Brifen U.S.A = http://www.brifenusa.com
- Gibraltar = http://gibraltartx.com
- Nucor Steel Marion = http://nsmarion.com
- Safence = http://www.safence.com
- Trinity = http://www.highwayguardrail.com
Contact Information

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