1ST INTERNATIONAL ROADSIDE SAFETY CONFERENCE
SAFER ROADS, SAVING LIVES, SAVING MONEY

Sponsored by
TRB Standing Committee on Roadside Safety Design (AFB20)

Co-Sponsored by
Transportation Pooled Fund Program Project No. TPF-5(329), including US State Departments of Transportation for Kentucky, Minnesota, Nebraska, Ohio, Washington, and West Virginia
TECHNICAL SESSION 7A: HIGH PERFORMANCE, INNOVATIVE, AND AESTHETIC BARRIERS

Moderator: Michael Dreznes, International Road Federation, Chicago, Illinois

Compliance Crash Testing of the CA ST-70 Side Mounted Bridge Rail
Vue Her, California Department of Transportation, Sacramento, California

Development of MASH TL-5 Steel Median Safety Barrier
Richard Clausius, ArcelorMittal Global R&D, East Chicago, Indiana

Development of a MASH TL-4 Roller Barrier
Frederick Mauer, Gregory Industries, Canton, Ohio

*Implementing MASH High-Tension, Three-Cable Guide Rail (HT3CGR) System in Ontario
Mark Ayton, Ontario Ministry of Transportation, Ontario, Canada (*Invited Presentation)
IRSC Technical Session 7A:
High Performance, Innovative, and Aesthetic Barriers

Implementing MASH
High Tension Three Cable Guide Rail System in Ontario

Mark Ayton, P. Eng.
Senior Engineer, Highway Design
Highway Standards Branch
Ontario Ministry of Transportation (MTO)

June 14, 2017
Implementing MASH High Tension Three Cable Guide Rail System in Ontario

- Highway Safety in Ontario
- MTO MASH Implementation Policies and Standards
- Cable Guide Rail History in Ontario
  - Advantages and Disadvantages
  - Replacement Pilot Projects
  - Replacement System Testing
- Pilot Project In-Service Performance
- MTO Implementation
- Lessons Learned
- Next Steps
Highway Safety in Ontario:

Ontario Statistics (2013):
- 415,600 Square Miles
- 13.5 M Population
- 8.9 M Registered Motor Vehicles
- 9.6 M Licensed Drivers
- MVC Fatality Rate = 0.54/10,000 Drivers
- 518 Traffic Fatalities (2nd lowest since 1944)

Provincial Hwy Infrastructure (2016)
- 2697 Km Freeways
- 7378 km Arterial Roads
- 2435 km Collector Roads
- 4485 km Local Roads
- 1778 km Concrete Barrier
- 2275 km W-Beam
- 2385 km Cable Guide Rail
- 21 km High Tension Cable Guide Rail
- 98 km Box Beam Guide Rail
- 12,924 W-Beam Terminals
- 703 Crash Cushions
Highway Safety in Ontario

Licensed Driver Population and Fatality Rate: 1975-2013

- 1976: Seatbelt use becomes mandatory
- 1977: Concrete median barriers
- 1980s: Temporary concrete barriers in construction zones
- 1982: Partially paved shoulder program
- 1982: Child car seats become mandatory
- 1988: Energy absorbing guide rail terminals
- 1991: Ontario Tall Wall concrete median barrier
- 1995: Shoulder rumble strips on rural freeways
- 2001: Ignition Interlock Program
- 2001: Fully paved shoulders on 4-lane freeways
- 2005: Mandatory Booster Seats
- 2006: One Person, One Seatbelt
- 2009: Modern Roundabouts
- 2009: Speed limiters for large trucks
- 2009: Warn range sanctions
- 2009: Ban on hand-held devices
- 2010: Zero BAC for 21 & under
- 2010: New Ignition Interlock and Vehicle Impoundment Programs
- 2010: Centre line rumble strips
- 2009: Street Racing Legislation

1988: Administrative Driver's Licence Suspensions, dedicated R.I.D.E. program funding
1994: Graduated Licensing System (GLS) introduced
1996: Vehicle Impoundment Program
1999: Fully paved shoulders on 4-lane freeways
2001: One Person, One Seatbelt
MTO MASH Implementation Policies and Standards:

All MTO Construction Contracts advertised after the following dates that include new installations of roadside safety hardware shall specify systems that meet AASHTO MASH:

- May 27, 2016: W-Beam Guide Rail including installations over shallow culverts
- September 1, 2016: W-Beam Terminals (SBEAT)
- December 31, 2016: Cable Guide Rail (Roadside)
- TBA: Crash cushions, bridge rails, transitions, all other longitudinal barriers, all other terminals, sign supports, and all other breakaway hardware
- TBA: Temporary work zone devices, including temporary barriers
Cable Guide Rail History in Ontario

- Cedar posts - 3.6 m c/c
- 12.6mm dia 7-wire steel cables
- Cable breaking strength 74 to 100kN
- 1.0m$^3$ concrete terminals - 300m

MTO Crash Test (1967):
- 1800 kg station wagon
- 80 km/h at 25°
- 107m (351’) test installation length adjacent to 3H:1V ditch
- 1.68 m dynamic deflection
Cable Guide Rail:

Advantages

- Lower initial construction cost
- Lower deceleration forces during vehicle impacts
- Open design prevents snow drifting
- Minimal visual obstruction

Disadvantages

- Minor/nuisance impacts require repairs and higher level of maintenance (tension)
- Larger deflections require larger working widths
- Increased deflection on inside of curves
- Major impacts result in system being non-functional
Cable Guide Rail: Replacement Pilot Projects

Hwy 144 – Northeastern Ontario
- Sudbury to Timmins – 174 km
- Original construction late 1960s
- Narrow roadway – 10’ (3m) lanes with 3’ (0.9m) shoulders
- Steep 1.25H:1V rock fills
- Low traffic volumes – north sections 1,100 to 1,700 AADT
- 80km/h Posted Speed Limit
Cable Guide Rail: Replacement Pilot Projects

Hwy 144 – Northeastern Ontario

- 29 km 3-cable guide rail (CGR)
- 8,000+ cedar posts
- Average post replacement rate of 1,016 per year (2010 – 2015)
- Reported collisions (2004 – 2013)
  - 173 of 1846 MVC involved CGR
  - 34 of 173 involved injury
  - 3 of 173 involved fatality
- 4 pavement rehabilitation projects scheduled for 2013 – 2015 (104 km)
Cable Guide Rail: Replacement Pilot Projects

Alternative replacement systems considered:

**AASHTO SGR01 (B-64)**
- Report 350 TL-3
- 3-19mm dia 3x7 wire rope
- 1600mm (63”) long S75x8.5 steel posts with soil plates at 1.2m to 4.9m c/c
- 2.1m to 3.3m deflection

**NY DOT (M606)**
- Adjacent to 2H:1V slopes, longer 2134mm (7’) posts with 610x200mm

**AASHTO SGR38 (B-211)**
- MASH TL-3
- 2743mm (9’) long W150x13.5 steel posts at 1.905m c/c
- 1.46 dynamic deflection
Cable Guide Rail: Replacement Pilot Projects

Alternative replacement systems considered:

Low tension 3-cable guide rail placed adjacent to 1.5H:1V slope

- Report 350 Test 3-11
- 1600mm (63”) long S75x8.5 steel posts with 610x610 soil plates at 1.2m c/c
- 151m (494’) long test installation
- Subsequent testing with offset behind posts to slope breakpoint increased to 1.2m was successful (3.3m dynamic deflection) B-191

MwRSF Research Report No. TRP-03-155-05, Feb/05.
Cable Guide Rail: Replacement Pilot Projects

Replacement system selected for first Hwy 144 Pilot Project in 2012:

Blue System High Tension 4-Cable Slope Barrier System

- CEN 1317 N2S (TB32 – 1500kg passenger car, 110km/h, 20°)
- 2100mm (82.7mm) steel U-posts at 3m c/c on 3H:1V slope
- Test installation length = 108m (354’), posts on 3H:1V slope 0.75m beyond breakpoint
- Dynamic deflection = 1.85m
- 4 contracts – 141 installations (24km) between 2013 and 2015
Cable Guide Rail: Replacement System

Further crash testing in 2015 of system according to MASH on 2H:1V slope:

Blue System High Tension 4-Cable Slope Barrier System

- MASH Test 3-11
- 2100mm (82.7mm) steel U-posts at 3m c/c on 2H:1V slope
- Posts on slope offset 250mm from breakpoint
- Test installation length = 108m (354’)
Cable Guide Rail: Replacement System

Further crash testing in 2015 of modified system according to Report 350 on 2H:1V slope:

Blue System High Tension 4-Cable Slope Barrier System

- Report 350 Test 3-11
- 2100mm (82.7”) steel U-posts at 3m c/c on 2H:1V slope
- Posts offset 200mm from breakpoint
- Top cable height increased to 985mm
- Test installation length = 108m (354’)
Cable Guide Rail: Replacement System
Crash testing in 2016 with new post according to MASH on 2H:1V slope:

Safence HT3CGR Slope System:
- MASH Test No. 3-11 (B-276):
- Dodge Ram 1500
- 172.4m (566’) test installation length on 2H:1V slope
- 2.01 m dynamic deflection
- 2256mm (92”) steel rectangular posts at 2.0 m c/c
- 19 mm dia cables
- Posts offset 0.2m beyond breakpoint
Cable Guide Rail: Replacement System

Crash testing in 2016 of new post according to MASH on 2H:1V slope (small car):

Safence HT3CGR Slope System:
- MASH Test No. 3-10 (B-276):
- Nissan Tilda
- 176.4m (579’) test installation length on 2H:1V slope
- 1.41 m dynamic deflection
Cable Guide Rail Pilot Projects: In-Service Performance:

- 24km of Blue HT4CGR Slope System constructed between 2013 and 2015 on Hwy 144.
- No reported MVCs to date.
- 95 steel posts replaced in 2015, and 115 steel posts replaced in 2016 (vs average of 1016 cedar posts per year between 2010 and 2015).
- Oversize load impact in Feb/17 on outside of 290m radii curve damaged 26 posts, and cables encroached into traffic lane.
- Tube reflectors not staying attached to top of posts (20m spacing).
MTO Cable Guide Rail Implementation:

• Policy, design guidance, and construction standards issued Oct 14/16
• All MTO contracts advertised after Dec 31/16 that include new or replacement installations of 3-cable guide rail shall specify MASH High Tension 3-Cable Guide Rail for Slope and Shoulder installations.
• Between March/17 and June/17, 28 contracts advertised with 28km of HT3CGR shoulder and slope installations.
Cable Guide Rail Lessons Learned (to date):

- Should have accelerated required contractor installer training to occur prior to contracts being advertised.
- Should have considered phased in implementation of new system into contracts in various parts of province.
- Standard requires 10cm high band of retroreflective tape on posts between top and middle cable instead of tube reflectors (20m spacing).
Cable Guide Rail Next Steps:

- Issue updated guidance and standards for maintenance/repair of HT3CGR
- Issue updated guidance for emergency responders for working around HT3CGR
- Review guidance and standards for installations on tight curves (inside and outside)
- Update construction standard to specify additional acceptable MASH systems crash tested on 2H:1V slopes
- Complete review and evaluation of costs for construction and maintenance of MASH HT3CGR vs MASH W-Beam
- Implement MASH HTCGR terminal(s) – currently specifying Report 350 terminals
- Implement MASH HTCGR to MASH W-Beam transition(s)
- Implement MASH W-Beam to Bridge Rail transition/connection
1ST INTERNATIONAL ROADSIDE SAFETY CONFERENCE
SAFER ROADS, SAVING LIVES, SAVING MONEY

Sponsored by
TRB Standing Committee on Roadside Safety Design (AFB20)

Co-Sponsored by
Transportation Pooled Fund Program Project No. TPF-5(329), including US State Departments of Transportation for Kentucky, Minnesota, Nebraska, Ohio, Washington, and West Virginia