Wire Rope Barrier Systems

REAAA NZ Roadshow 22nd August – 2nd September 2014

Grant Gordon – AMA Traffic Safety Engineer & Opus Senior Roading Engineer

New Zealand Government
Wire Rope Barrier Systems

- WRBs in various forms have been around for some time.
- Early American examples date back to 1930’s.
- Auckland motorway examples from 1960’s.
- Other examples have been used around NZ.
Early 1960’s WRB’s on southern approach to AHB
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- Improved incrementally over time
- Adoption of formal testing procedures - NCHRP 350
- Tested under ideal conditions – standard soils, flat terrain
- Challenge to match applications as close as possible to tests
- Requires attention to:
  - design
  - installation
  - maintenance
- Vulnerable to compromises like any barrier system

Auckland Motorways

New Zealand Government
Here is a typical median barrier installation

It is rated to NCHRP 350 TL-3 (2T pickup, 100km/h, 25 deg.)
Question:

could we expect it to contain one of these:
Answer:

yes...

...but with large deflections
How about one of these:

…..mmm?
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...or maybe one of these:

....almost (clear of lanes)
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**Wire rope barriers**

- Can contain very large vehicles
- Can fail to capture rolling, or wedge shaped vehicles
- Cables with weak posts distribute loads
- Deflect more than other barriers
- Impart lower re-directive forces
- Steering / suspension damage vehicle less likely
- Vehicles often drive away after impact
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**Wire Rope Barriers are vulnerable**

- High cable tension required to match test results
- Cable tension not documented at installation, or monitored
- Systems only as good as installation allows
- Designers need to understand correct application
- Constructors need to ensure correct installation
- Maintainers need to keep the system up to spec
Wire Rope Barriers are vulnerable

- System can work with:
  - tension below specification
  - some posts damaged
  - a cable out
- Important to maintain condition, rectify faults

... so what are the problems areas?
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Need to consider the three areas

- Design
- Installation
- Maintenance
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Design

- Install in a manner best matching tested criteria
- Flat approaches, ≤10%
- Foundation width and depth to prevent rotation
- Retaining walls must take lateral loads from posts
- Designers fully conversant with system requirements
- Use latest product manuals
- Designers should be NZTA qualified
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Design - layout options

- NZTA, Australian RCA’s require 4 cable TL-4 systems
- Avoid under-run or incorrect engagement
  - Beware of kerbs, ditches, back slopes
- Post spacing ≤ 3.5m to avoid cable spreading & penetration
- Adjust post spacing to suit alignment per manual
- Protect or use crash tested terminals
  - Motorcyclists vulnerable at anchors
  - Avoid anchors in high risk locations
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**Design - cable tension**

- Cable tension is difficult to maintain, so anchor blocks should be conservatively designed.
- Get soil strength information to ensure correct foundation design.
- With new formations, ensure drawings clearly specify:
  - required soil strength, to be confirmed on site by testing,
  - profile details.
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Design - anchors

- Ensure adequate overlap at transitions
- Austroads GRD6 departure angle based on statistics
- What if impact energy exceeds tested values?
- Severe consequence
- Must protect with cushion
- NZTA prefer points of containment to overlap
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**Design - operational considerations**

- Eliminate maintenance in front of barriers
- Maintenance clear of moving traffic
  - High volume high speed SHs
  - Where visibility limited
- Risk of sudden flow breakdown, cross centreline manoeuvres
Installation

- Before confirming foundations, check soil strength (SPT, Vane)
- Re-soiling or landscaping affects system height
- Re-tensioning after settling in, to ensure anchors performing
Installation - QA

- Record installation details
- Compliance with manufacturer, RCA criteria
- Foundation shape & depth correct
  - Avoid bowl shape
- Include photos
- Use NZTA qualified certifiers / reviewers
- Owners manual to identify system and maintenance requirements
  - Re- tensioning frequency, component lifespans
**Maintenance - impact damage**

- Small hits have minor effect on cable tension
- Cumulatively reduces cable tension, as do high energy impacts
- Check the entire length of cable run after impact
  - Damage can occur remote from the point of impact
- Check turnbuckles, anchors for damage at both ends
- Check turnbuckles near the impact for damage (bending)
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Maintenance - impact damage

- If significant damage, consider upgrading or replacing old systems
  - Three cable to four cable system
- Consider consequences of cable failure or maintenance outage
  - TSLs, especially median outages
  - LOS protocol and effect on carrying spares
  - 4 cable system may function with one cable out
  - Special considerations at high capacity/risk sites
- Protect crews working in median from both directions
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Maintenance - turnbuckles and cables

- Limited scope for re-tensioning
- Cables will need to be shortened
- Swaged fittings factory fitted,
  - Repair down time
- Turnbuckles corrode.
  - Avoid damaging Densotape during re-tensioning
  - Replace turnbuckles & cables after 25y depending on environment
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Maintenance - cable tension

- Cable tension varies with temperature,
  - Include accurate thermometer in re-tensioning kit
- Cable tension relaxes over time
  - Systems relax after initial tensioning
  - Check cable tensions within a year of opening
- Subsequent re-tensioning frequency determined by impact history and soil performance.
  - If in doubt, check it!
Maintenance - grading changes

- Keep overlays clear of barrier systems

- Or adjust system height adjusted to suit (re-installation)
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Maintenance - grading changes

- Foundation soil erosion
  - rain and vehicle wind blast
  - removal of vegetation
  - soil swelling cycles
- Shallow foundations vulnerable
- Post foundations rotate
  or snag vehicles
Conclusion

- WRBs can outperform more rigid systems
  - Occupant safety
  - Vehicle containment and redirection
- WRBs often quicker and easier to repair
- Attention to design, installation, and maintenance to achieve desired performance
Thank You

Any Questions?