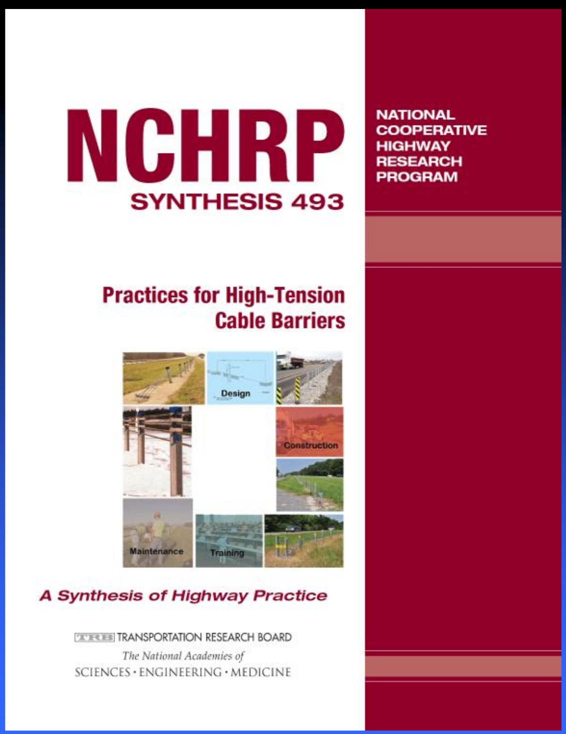
Practices for High-tension Cable Barriers



Presented to the AASHTO Subcommittee on Maintenance

Providence, Rhode Island
Wednesday, August 2, 2017

Synthesis Objectives

To identify and report on the state of the practice for HTCBs used in medians, including:

- Specifications and special provisions
- Design standards, criteria, and warrants
- Construction and maintenance procedures
- Need for additional study

Project Team

Karen Boodlal

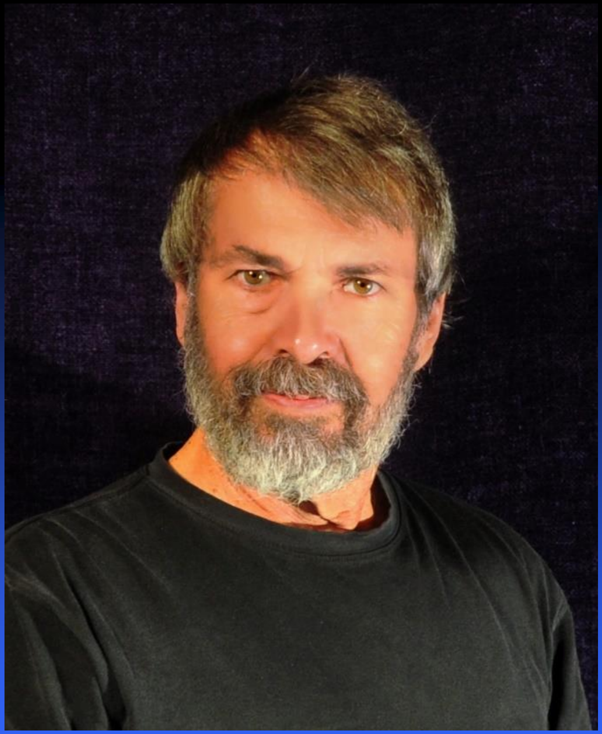
Mrs. Boodlal has over 15 years of experience with highway safety in general and with roadside safety in particular.

She served as the Project Manager for the NCHRP Synthesis Report 493, Practices for High-Tension Cable Barrier as well as FHWA Roadway Departure Systems technical assistance program. She is a member of TRB Committee AFB20 on Roadside Safety Features, and AASHTO Task Force 13.

Project Team

Richard Powers

Mr. Powers had over 30 years of roadside safety design experience with FHWA. After developing the first draft of the Roadside Design Guide in 1989, he was the primary instructor for the NHI RDG for many years. Prior to his retirement from the FHWA in 2007, his primary duties included reviewing crash test reports for traffic barriers and other safety hardware to determine compliance with appropriate national standards and their acceptability for use on public roads, and providing guidance to state, local, and other government agencies on matters relating to roadside safety.



On top of Cable Barrier for 50 yrs.

Study Approach

- Collect/review materials supplied by states and manufacturers
- Review FHWA acceptance/eligibility letters
- Review other research efforts
- Review selected in-service evaluations
- Survey agencies
- Case studies

Report Format

- Chapter one–Introduction
- Chapter two–Literature Review
- Chapter three–Summary of Survey Responses
- Chapter four–Case Examples
- Chapter five–Conclusions

Presentation Overview

- Brief History of Cable Barrier Usage in the United States
- Overview of High-Tension Cable Barriers in use
- Primary findings of the synthesis study

History of Cable Barrier Usage in the United States

- Started as low tension generic design
- Often cost-effective in freeway medians
- First high-tension proprietary design installed in Oklahoma City around 2000
- Several additional proprietary designs developed over time
- Significant increase in use to present day

Early Cable Barrier Testing

Barrier Classification

Type		Deflection
Rigid	→	0-1 ft.
Semi-Rigid	→	2-5 ft.
Flexible	→	Over 5 ft.

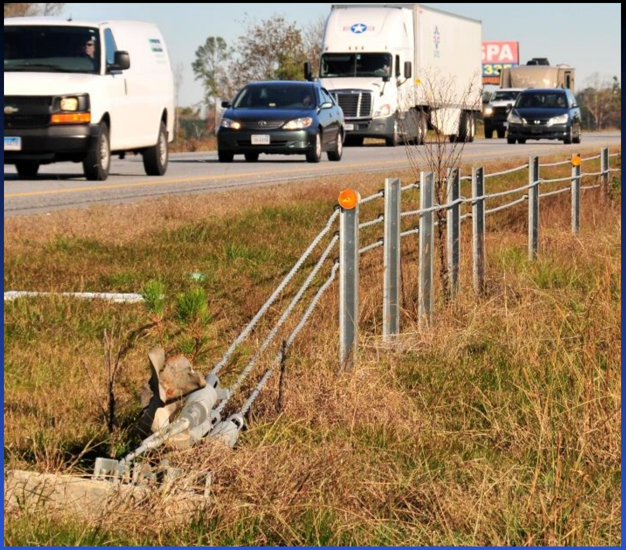
Types of Flexible Barrier

- W-beam (weak post)
- Low tension cable barriers
- High-tension cable barriers

MASH TL-3
Weak Post W-beam Barrier

Barrier Systems: Flexible Barriers

- Low Tensioned Cable Barrier
  - Generic System
  - 3 cables design with center cable on opposite side of the post from top and bottom cables.
  - Design deflection of approximately 12 ft.
  - Generic crashworthy terminal.



Flexible Barrier NCHRP 350

Barrier Systems: Flexible Barriers

- High Tension Cable Barrier
  - Five different designs available
  - All designs are proprietary
  - Each design has less deflection upon impact than low tension cable barriers
  - All generally have less damage when struck, resulting in less maintenance
  - Each requires a unique proprietary terminal

High-Tension Cable Barriers

- Brifen
- Gibraltar
- Nucor Marion Steel
- Trinity (Cable Safety System-CASS)
- Safence

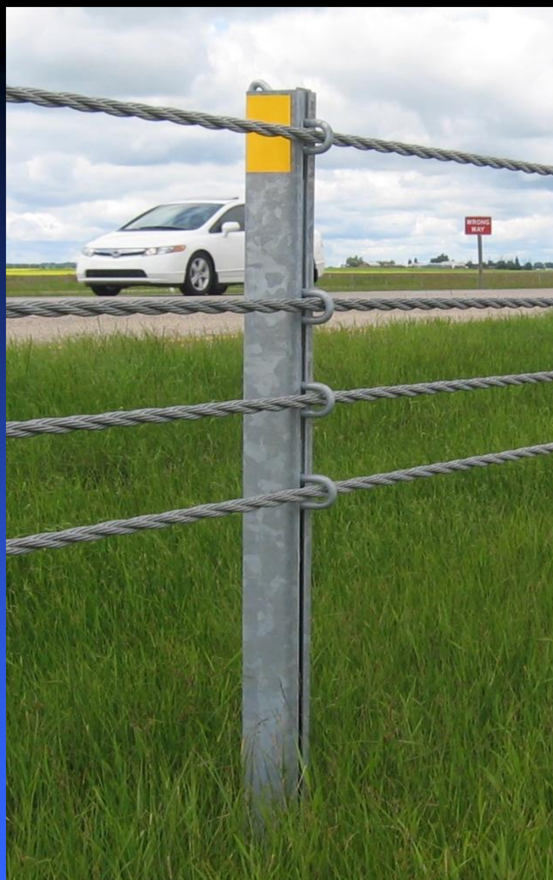
NOTE: All of the High tensioned Cable Barrier Systems tested to TL-3 & TL-4. Anchor Terminal Systems have been developed for each product. Some systems have been successfully tested on 4H:1V slopes.

Brifen USA

http://www.brifenusa.com

- Interwoven cables create additional friction at each post which may reduce deflection upon impact.
- 3 or 4 cable design available.

Gibraltar



http://www.gibraltartx.com

- Hairpin connection at each post set cable heights.
- Adjacent posts are on opposite sides of the cables
- 3 or 4-cable design available.

Nucor Steel Marion

http://www.nucorhighway.com

- Uses special locking hook bolts on U-channel steel posts.
- 3 or 4-cable design available.

Trinity Industries

(Cable Safety System-CASS)

http://www.highwayguardrail.com

- Posts have a waved-shape slot located in the web of the upper portion of the post.
- 3 or 4 cable design available.


TRINITY CASS

Safence – Gregory Industries

http://www.safence.com

- Posts have slot located in the upper section of the web.
- 3 or 4 cable design available.


Safence
Gregory Highway
Products

Basic Cable Barrier Construction

- Post can be Direct Driven or Socketed
- Sockets can be Driven or Cast in Concrete
- Posts are placed in Sockets and Cables are hung from Posts
- Cable heights are pre-determined through hardware
- After a hit, bent Posts are removed and a new Post is placed in Socket
- Cables are re-hung, tension is checked and system is ready

Cable Tension

- Tension is set based on ambient temperature
- Tension is achieved through a two step tensioning - Initial and Final
- Initial tension is set based on temperature and system will sit for a pre- determined period of time - for cable "seating"
- Final tension is set based on temperature after "seating", tension will fluctuate with temperature
- Tension should be checked and recorded after every hit

High-Tension Cable Impact

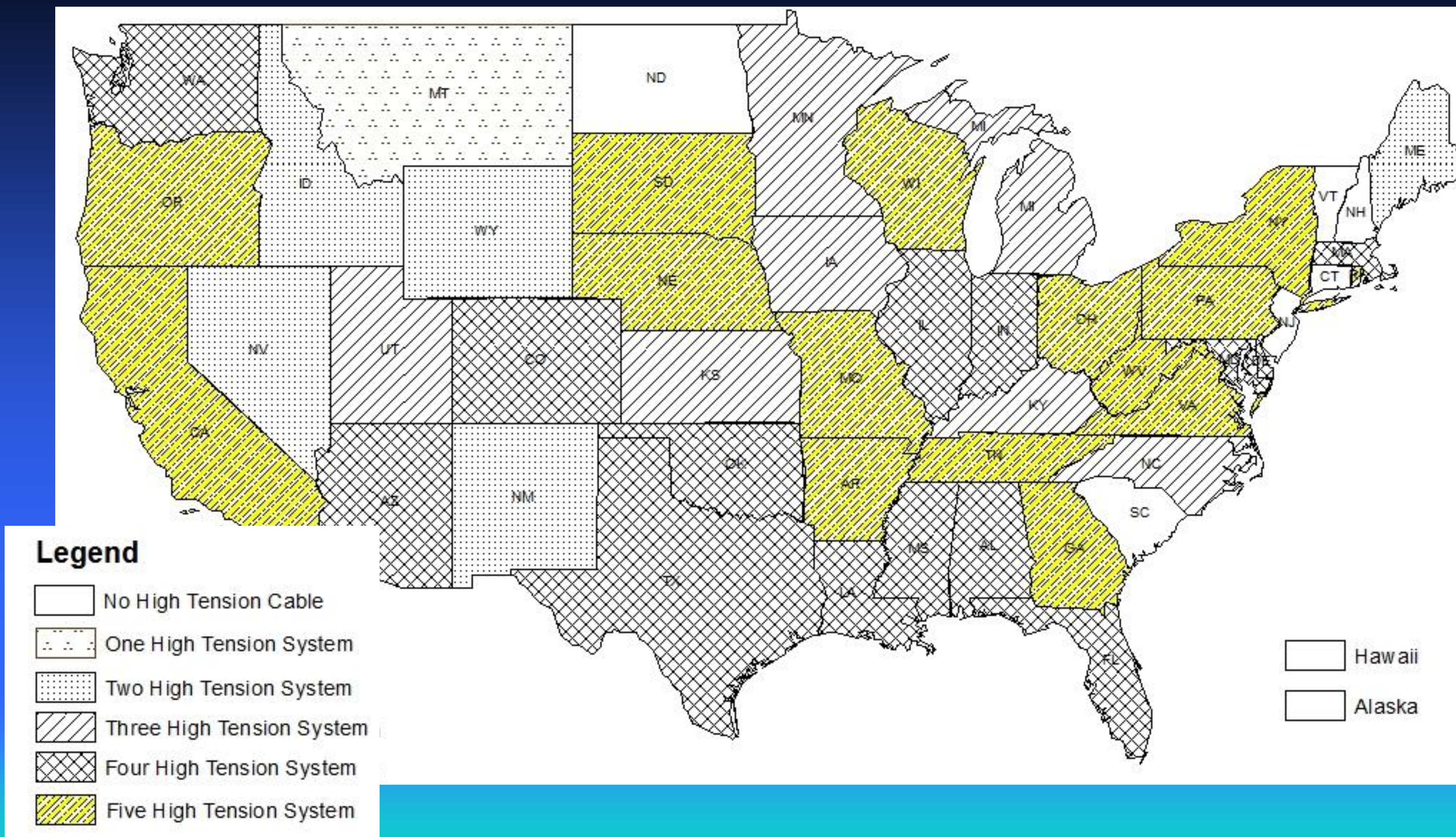
High-Tension Cable Impact

Surveying the States

- Survey was sent out to each State agency by NCHRP.
- Questions were based on HTCB use in the median.
- The survey was divided into three sections:
  - Specifications and Design Issues
  - Construction Concerns and
  - Maintenance Practices
- NCHRP sent out the survey to the SCOD and instructions were provided on getting input from the agency's Construction and Maintenance for completion.

Primary Findings

- High Tension Cable currently in use.



Primary Findings

- High Tension Cable currently in use.

	No of States
Minimum number of cables – 3	8
Minimum number of cables – 4	24
Do not specify a minimum number of cables	10
Minimum system Test Level – 3	28
Minimum system Test Level – 4	19
Do not specify a minimum Test Level	2

Primary Findings

- High Tension Cable Specifications/Special Provisions used by 8 states
- Generic specifications used by 10 states
- Special provisions alone used by 17 states
- Manufacturers specifications/installation manuals used by 7 states

Testing Cable Barrier in Sloped Median (6H:1V)

Primary Findings

Barrier Placement in Median:

- On 6H:1V slopes, avoid area one foot on either side of ditch (median) bottom and eight feet up either side from the one foot offset
- On 4H:1V slopes, avoid the area between four feet from the top of the slope and 20 feet down the slope
- Follow manufactures’ specific slope placement guidelines based on full-scale crash testing
- Critical for optimal performance

Locations for HTCB in Sloped Medians

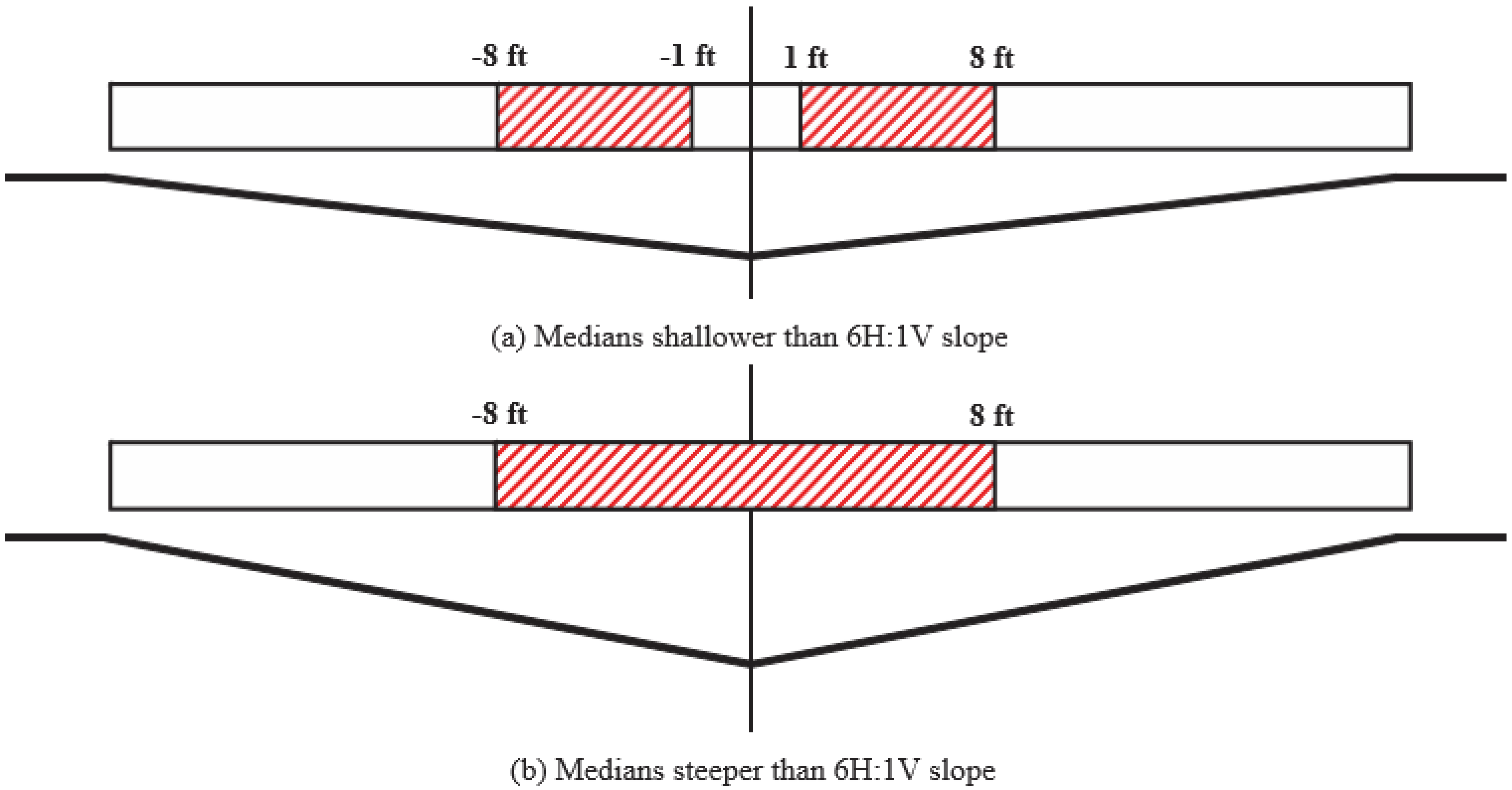


Figure 6.1. Underride criteria for V-shaped medians.

Locations for HTCB in Sloped Medians

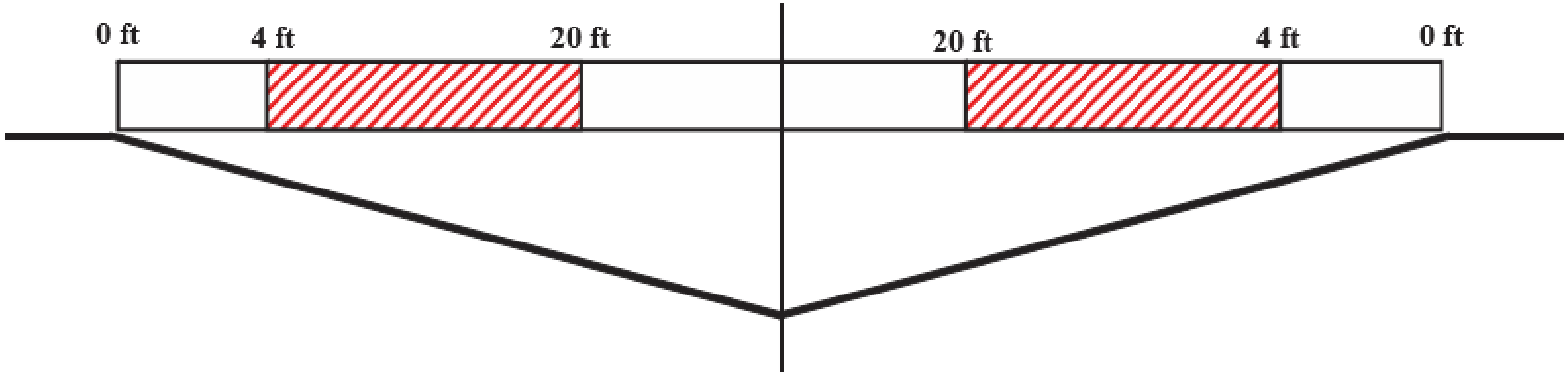


Figure 6.2. Override criteria for V-shaped medians steeper than 6H:1V slope.

Primary Findings

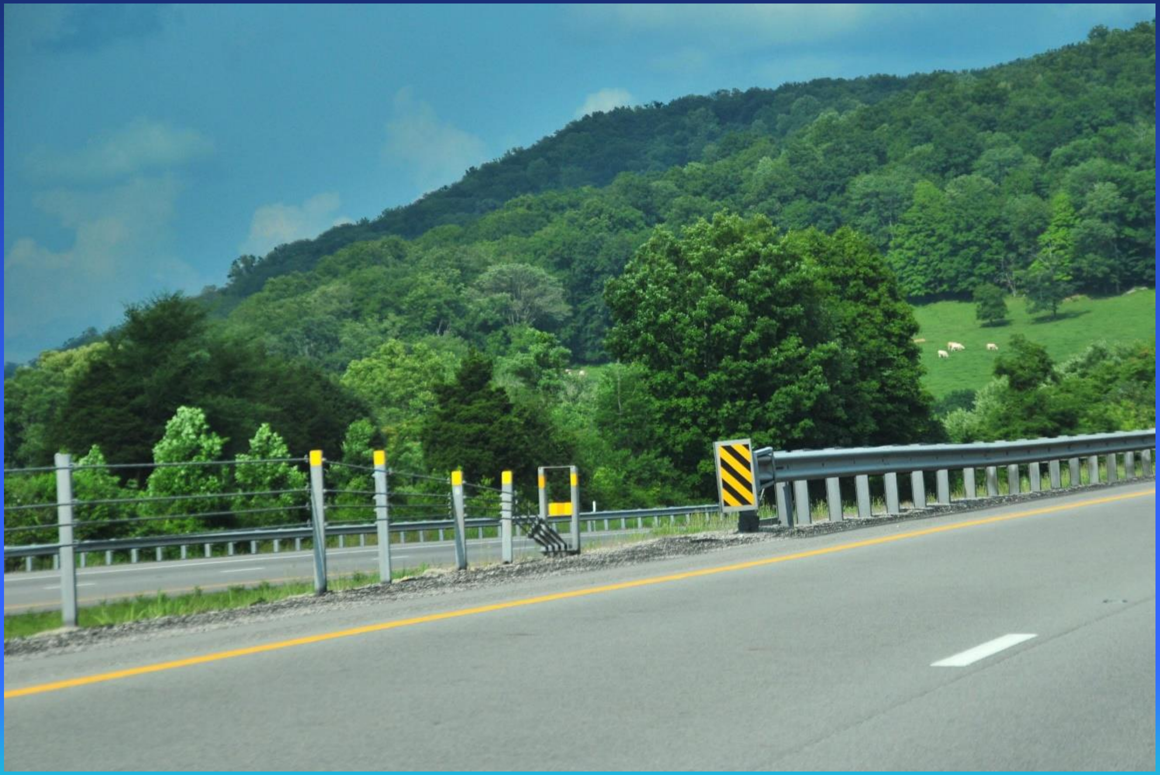
- **HTCB Anchor Placement and spacing** are determined by agency specifications in 16 states and by following the manufacturers' recommendations in 19 states.
- Some states set a **minimum and maximum cable run** between anchors.
- Most states use **socketed posts** verses driven posts and require the size and depth of the sockets be determined by the manufacturer.

Primary Findings

- **Overlap/connection to existing W-beam**
  - Terminate the cable barrier in advance of the stiffer system
  - Terminate the cable barrier behind the stiffer system
  - Terminate the cable barrier in front of the stiffer system (excluding concrete barrier)
  - Connect the cable barrier to the stiffer system (excluding concrete barrier)

Primary Findings

- **Terminate the cable barrier in advance of the stiffer system**



Primary Findings

- **Terminate the cable barrier behind the stiffer system**

Primary Findings

- **Terminate the cable barrier in front of the stiffer system (excluding concrete barrier)**

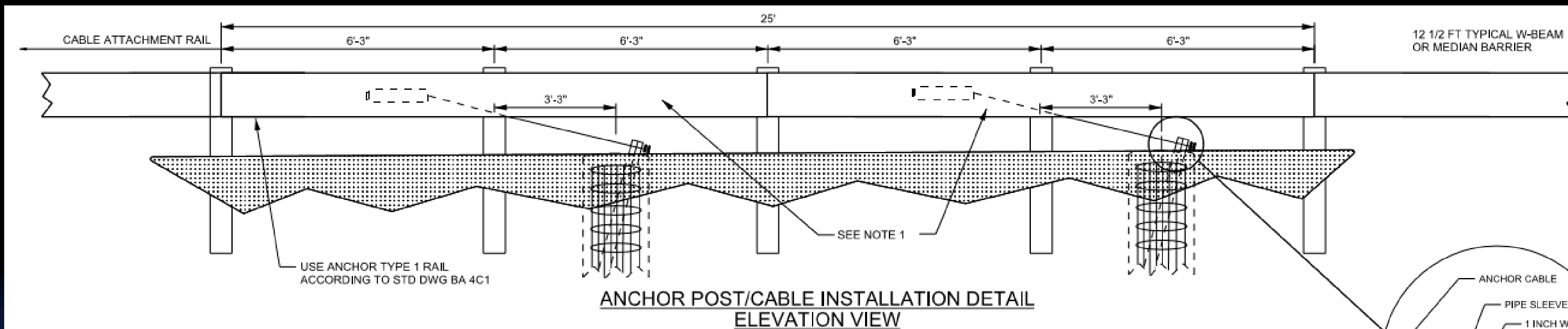
Primary Findings

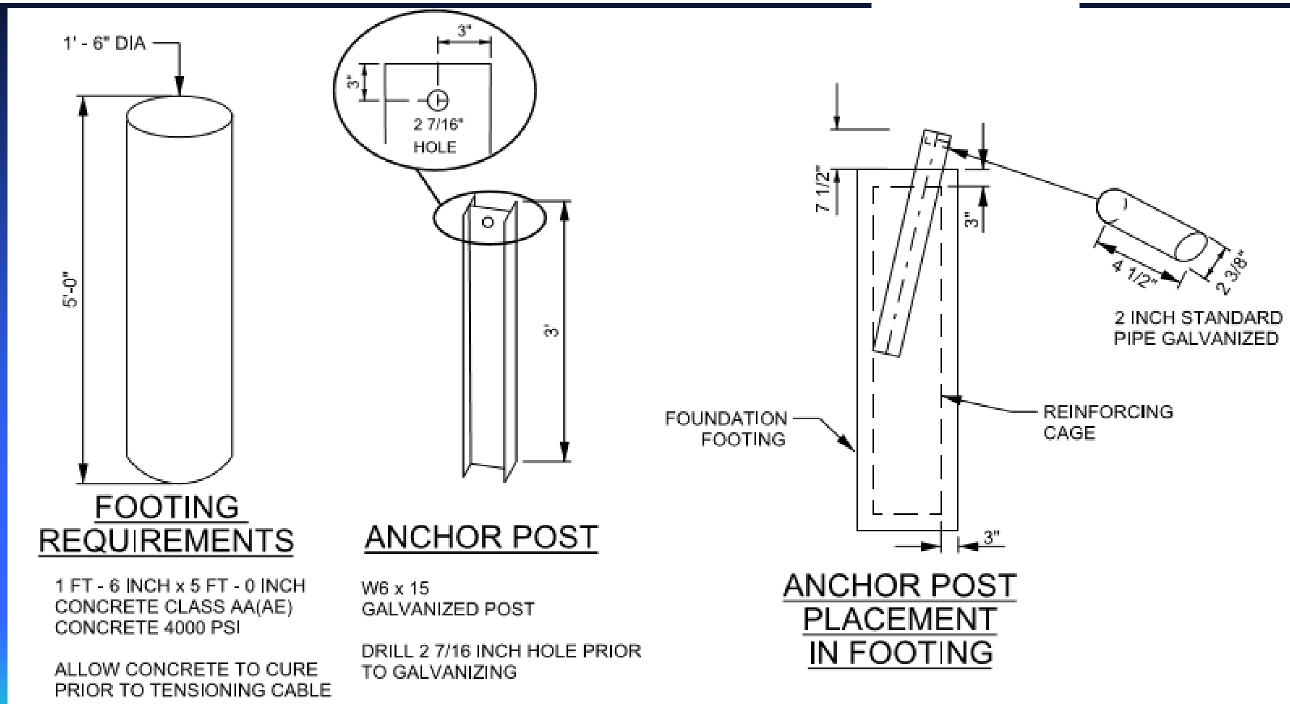
- **Connecting the cable barrier to the stiffer system (excluding concrete barrier)**

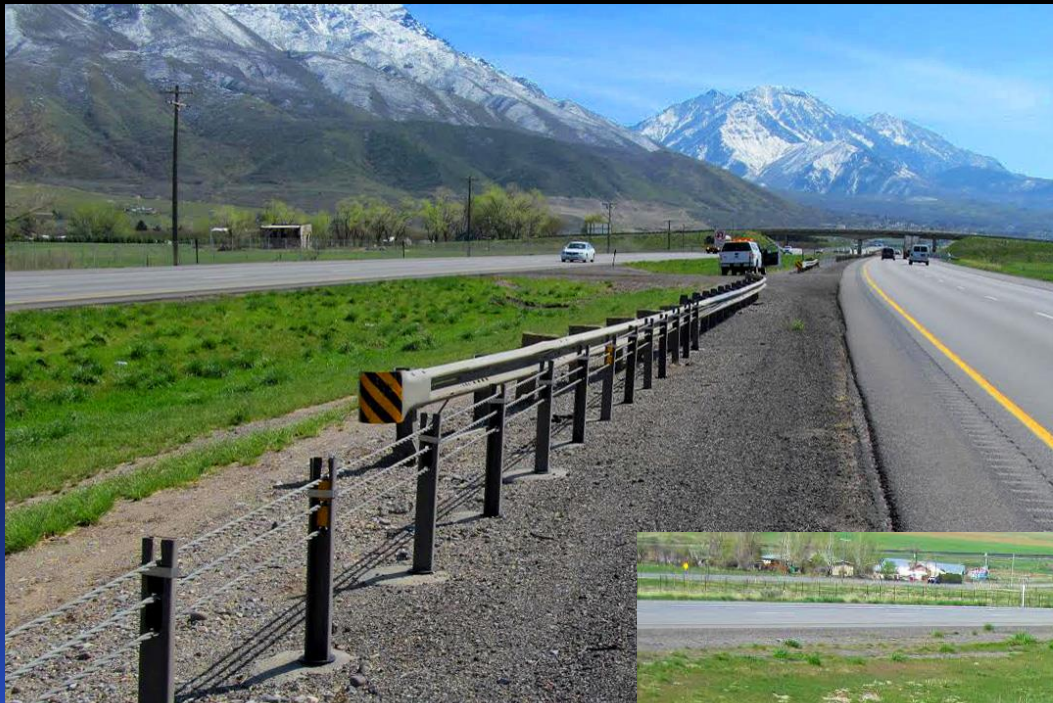
Primary Findings

- **Connecting the cable barrier to the stiffer system (excluding concrete barrier)**

Utah DOT Anchor Detail








Example Specifications/Special Provisions

- Most of the states using HTCB have developed specifications and/or special provisions for these barriers
- Summary information from two states representing both a geographical distribution and the diversity of detail will be presented

Rhode Island

Specifications for HTCB in Rhode Island include the following items:

- Description of Work
- Materials
- Basis of Acceptance
- Construction Methods
- Measurement/Payment

Michigan

Michigan has, by far, the most comprehensive series of Special Provisions addressing HTCB. In addition to the “standard” items, these include:

- Manufacturers’ Representative
- Consultation and Training
- Geotechnical Information
- Concrete Foundation Construction
- Terminal Foundation Monitoring

Maintenance Concerns

Routine:

- check and record tension periodically

Crash-related:

- Cut cables only in an emergency situation
- Release tension by releasing end anchor or releasing cables from several adjacent posts (some systems)
- If no other choices, cut turnbuckles, not cables themselves

Conclusions

- The synthesis report contains a “shopping list” of items for consideration in states’ specifications and special provisions related to HTCB selection, design, installation, and maintenance.
- These items are not included in all states’ specifications or special provisions, but the listing shown on the next slide is comprehensive.

- Description of work
- Materials
- Manufacturer’s representative
- Consultation and training
- Plans and shop drawings
- Geotechnical information
- General HTCB system design
- Concrete foundation construction
- HTCB construction and installation
- Cable terminal foundation monitoring
- Measurement and payment

Research Suggestions

- In-service performance evaluations documenting crash performance of each HTCB design, long-term materials performance, and maintenance concerns
- Revised test matrix and evaluation criteria allowing comparison of different HTCB systems performance on slopes

QUESTIONS?