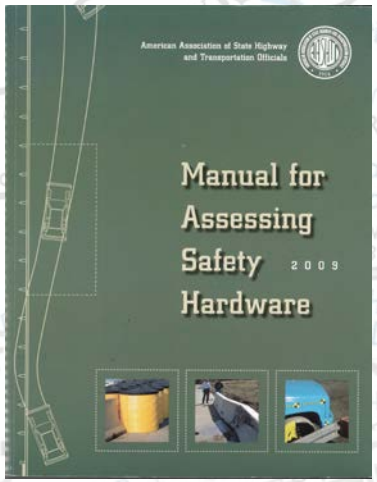
# MASH Implementation and Design Considerations

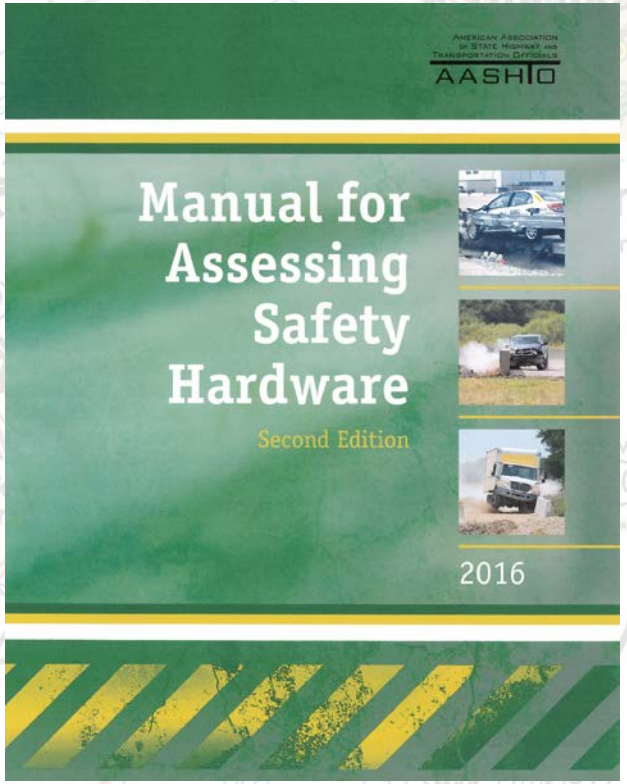
David J. Welch, P.E.
Design Services Engineer
ALDOT Design Bureau
welchd@dot.state.al.us

# What is MASH?

- **M**anual for **A**ssessing **S**afety **H**ardware

- Current Version is the Second Edition (2016)




# What is MASH?

From the Preface

- “This document’s purpose is to encourage consistency in crash testing and evaluation.”

- “Note that MASH addresses only the crash testing of roadside safety features.”

# NCHRP 350 vs MASH (2009)

- Changes to Test Matrices include
  - Impact angles
  - Speeds
  - Location of impacts
  - Critical hit locations
- Changes in Test Installations
- Changes in Evaluation Criteria
- Changes in Test Documentation
- Changes in Performance Evaluation

# NCHRP 350 vs MASH (2009)

- Changes in Test Vehicles include
  - Increased weights
  - Age of test vehicles
  - Other

# MASH 2009 vs MASH 2016

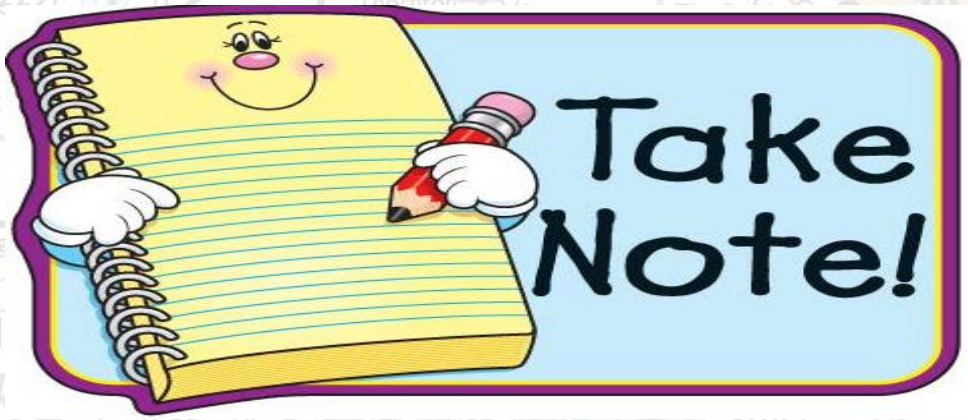
- “Some of the more significant changes include:
  - A new matrix for cable barrier testing on slopes
  - Modifications to several test vehicle dimensions
  - Updated test documentation requirements”

# Why do the differences matter?

- The following implementation information all pertains to the 2016 version of MASH. The Joint Implementation Agreement between FHWA and AASHTO is very specific about applying the 2016 version requirements.

- The differences show the continued evaluation and evolution of crash testing and associated requirements.

# MASH Adoption




- MASH is an AASHTO Guideline
- The FHWA / AASHTO Joint Implementation Agreement VERY specifically applies MASH to NEW CONTRACTS let on the NATIONAL HIGHWAY SYSTEM.
- ALDOT has chosen to apply MASH guidelines to **ALL** State, US, and Interstate routes, regardless of NH designation as well as NH routes as required
  - May 15, 2017 Memorandum from Steve Walker to Bureaus and Regions.
  - The letter is in regards to Guardrail, but mentions other MASH items as well.

# Implementation Schedule

- Agreement Requirement by December 31, 2017
  - W-beam barriers (i.e. guardrail) and cast-in-place concrete barriers
- ALDOT Status
  - Guardrail changes were implemented with the July 28, 2017 letting
    - Changed the height to 31” and the splice location to mid-post.
    - Changes are reflected in the 2018 ALDOT Special and Standard Drawings
  - Concrete barriers were implemented with the January 26, 2018 letting
    - Changed from the “Jersey” shape to the Constant Slope Face (CSF) minimum 42” height
    - Changes handled through Special Project Details this year and will be in the 2019 book

Video courtesy of the Roadside Safety Pooled Fund

Video courtesy of the Roadside Safety Pooled Fund

# Implementation Schedule

- Agreement Requirement by June 30, 2018
  - W-beam terminals (i.e. guardrail end anchors)
- ALDOT Status
  - Guardrail end anchor changes were implemented with the January 26, 2018 letting and 2018 Standard and Special Drawings Book
    - There are no approved Type 10 series. A note was added to the 2018 book drawings prohibiting their use on NHS routes after June 30, 2018
    - There are three approved Type 20 series. Two are now Special Project Details and were required starting with the January 26, 2018 letting
    - Type 8 modified as a SPD in June 2017. Added to the 2018 book.
    - Type 13 end anchors are considered transitions and will be handled later

Video courtesy of Gregory Industries

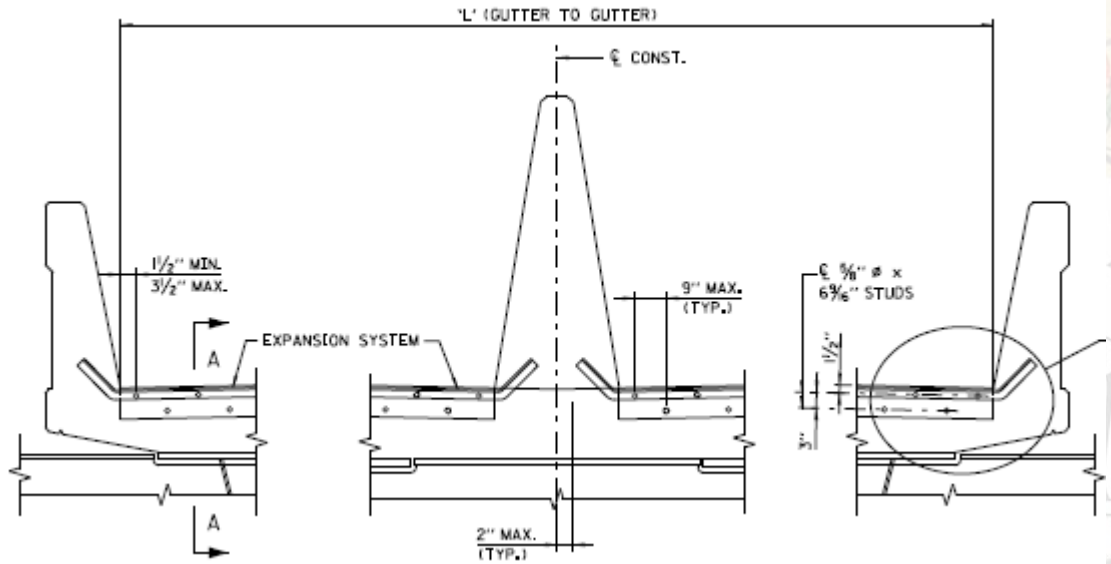
Video courtesy of Gregory Industries

# Implementation Schedule

- Agreement Requirement by December 31, 2018
  - Cable barriers, cable barrier terminals, and crash cushions (i.e. impact attenuators)
- ALDOT Status
  - Cable Guiderail changes are hopefully forthcoming.
    - There are a few manufacturer / products that have FHWA eligibility letters
    - To date, there are no ALDOT approved MASH cable guiderail systems
  - Impact Attenuators
    - Several manufacturers / products have FHWA eligibility letters
    - To date there are no ALDOT approved MASH impact attenuators

Video courtesy of Brifen USA

# Implementation Schedule




- Agreement Requirement by December 31, 2019
  - Bridge rails, transitions, all other longitudinal barriers (including portable barriers installed permanently), all other terminals, sign supports and all other breakaway hardware
- ALDOT Status
  - Bridge changes have been phased in over the past several months and are in almost full compliance
    - 36” height will require a transition to 42” minimum CSF barrier or 31” guardrail
  - Guardrail end anchor type 13 falls in this category. Currently researching non-proprietary systems to use
  - All others will be implemented as two or more become available through FHWA eligibility and ALDOT PEB approval

# Implementation Schedule


- Agreement Requirement for devices manufactured after December 31, 2019
  - Temporary work zone devices (including portable barriers)
  - NOTE: Items in this category meeting NCHRP 350 or MASH 2009 requirements can continue to be used throughout their normal service life.

- ALDOT Status
  - Portable barriers
    - Beginning research now to begin the transition
    - Would LIKE to see them implemented in the 2019 Standard and Special Drawing Book
  - All others will be implemented as two or more become available through FHWA eligibility and ALDOT PEB approval

# Issues with Implementation


- City / County
  - ALDOT's policy through the Design Bureau is to apply MASH to all State, US, and Interstate Routes as well as other NH routes that don't fall in these categories.
  - Right now, no policy on City / County routes in general
  - Some City and County routes are NH designated (Airport Blvd in Mobile)
  - NOTE, the designation to apply MASH standards is predicated upon the route system the road falls under (i.e. NHS) and is NOT predicated upon whether or not there is federal involvement.

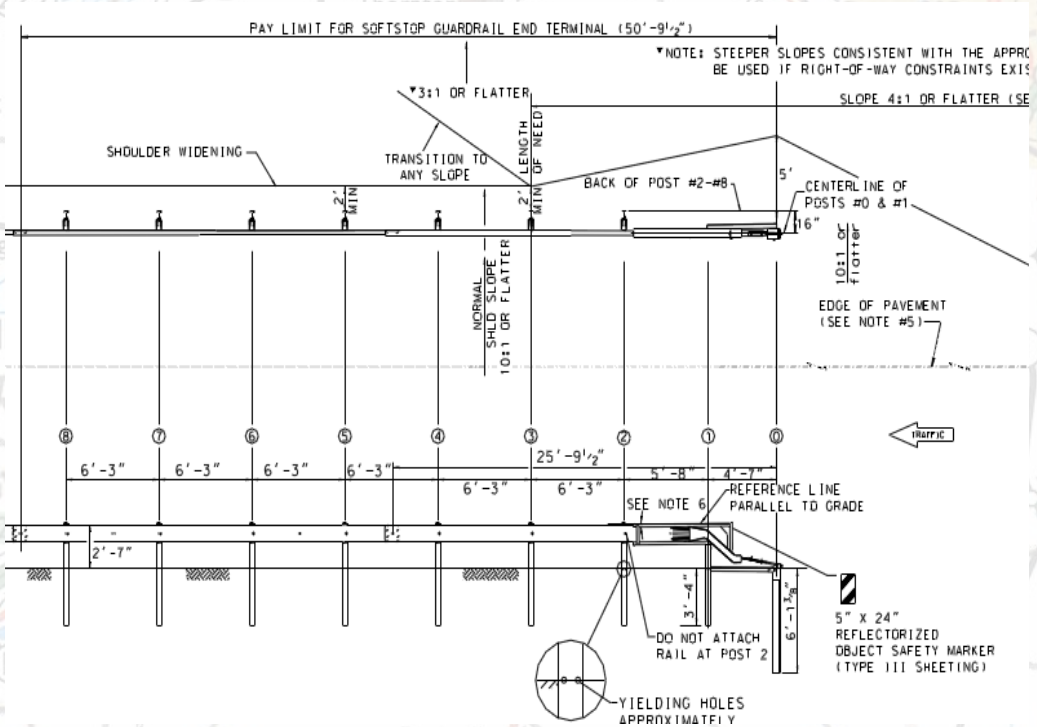
# Issues with Implementation


- IM Safety Scopes
  - Guardrail – ok if 26.5 inches or higher and not damaged. However, must replace steel blockouts, in which case, the composites allow raising either 2” or 4” without adjusting posts. Also, if changing the height, the splice location must be changed as well.
  - End Anchors – if they meet NCHRP 350 can stay for service life.
  - Median barrier – repair if needed. No policy to date on whether to repair existing standards or bring repaired section up to MASH.
    - Requires a transition from “jersey shape” to constant slope

# Issues with Implementation

- Maintenance Bureau MASH Implementation Policy
  - Policies are still in **DRAFT** status
  - Contact Mark Waits for assistance

# Issues with Implementation




- TL-2 / TL-3 end anchors
  - Difference is that TL-2 is for 45 mph and less, TL-3 is for 45 mph or greater
  - TL-3 end anchors can still be used for less than 45mph.
- There are three approved Type 20 series end anchors for TL-3. Two of these are reflected in the special project details.
- Only one of the three is approved by the PEB for TL-2.
  - A note was added to that drawing that a TL-2 is available upon request.
  - A separate pay item will not be established.

# Issues with Implementation

- SKT vs MSKT
  - 1/1/2018 Road Systems Inc. stopped producing the SKT Head for their Type 20 Series End Anchor.
  - They did get FHWA approval to use the MSKT head on a SKT system **BUT** this does **NOT** make the system MASH compliant.
  - There needs to be discussions about how to readily identify the NCHRP 350 compliant systems that utilize the MSKT head when repaired.

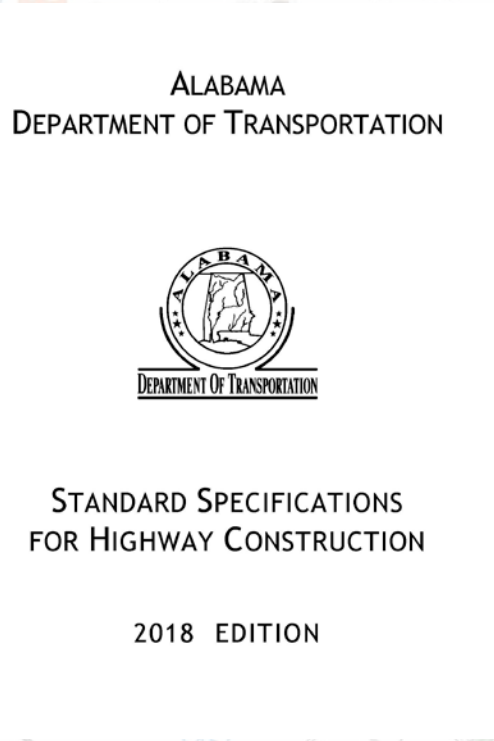
# Issues with Implementation

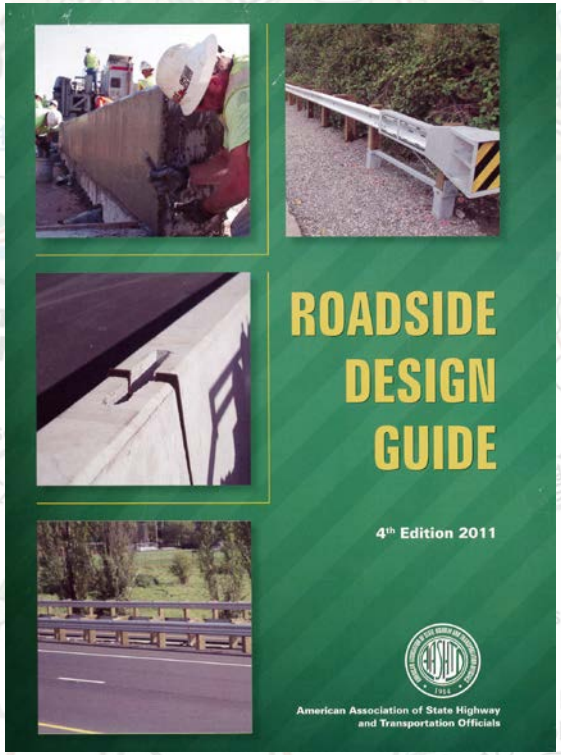
- Cable
  - MASH requires the same series of tests to be performed in each different installation location.
  - Prohibitively expensive for the manufacturers.
  - Some systems and some installation locations have been approved by FHWA. Need to research if any of ALDOT's "typical" placements have been approved.
  - Both the guiderail and terminals have to be MASH approved.

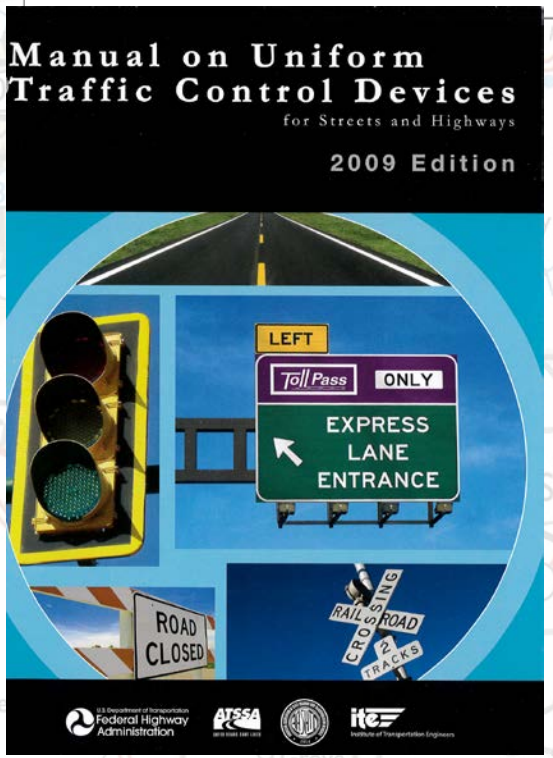
# Issues with Implementation

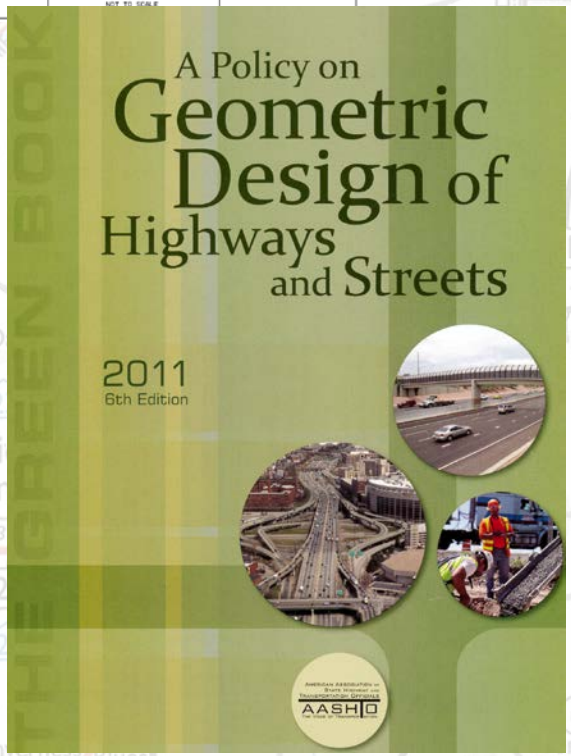

- Approvals
  - To date it has been up to the manufacturer or supplier to obtain ALDOT PEB approval
    - Includes all required FHWA acceptances and MASH documentation
  - PEB process does take time (3-6 months sometimes)
  - No clear answer on what to do if a MASH compliant product (really two) is not available by the deadline.  This hasn't been an issue so far.

# Design Requirements

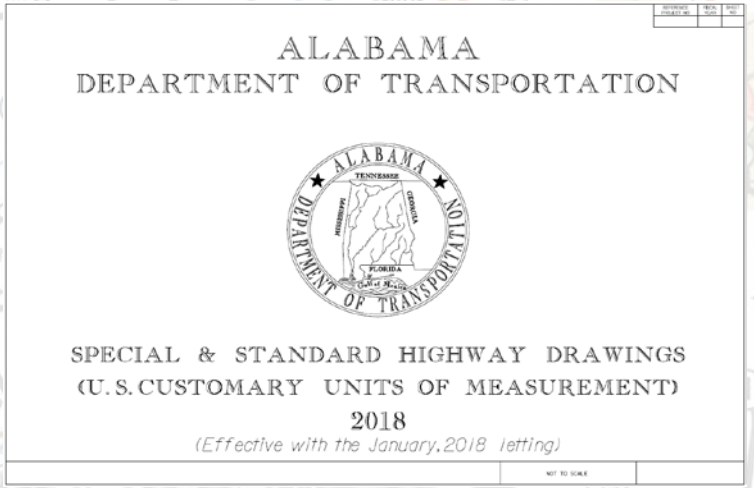



# Design Requirements


ALABAMA
DEPARTMENT OF TRANSPORTATION

SPECIAL & STANDARD HIGHWAY DRAWINGS
(U.S. CUSTOMARY UNITS OF MEASUREMENT)
2018
(Effective with the January, 2018 letting)

- Standard drawings vs special project details
  - As deadlines come and MASH items are implemented, some will be added to the book and some will require Special Project Details for extended periods of time.
  - Type 20 series end anchors: We had two approved and knew a third was in process, thus all are SPD for this year. Should all be in the book next year.
  - Type 10 series end anchors: Deadline is July of this year, so can still use on NH routes up to that time. A note added to sheets in the book denoting the date and use. Will NOT be in the book next year.
  - CSF barrier: Since this was such a radical change, we made SPD this year to handle issues that arose during construction. Should all be in the book next year.

# Design Requirements

- Implemented in the 2018 book
  - 303 – MASH compliant Type 8 end anchor
  - 326, 326a, & 327 – changed height and splice location of guardrail
- MASH related SPDs as of Monday (4/2)
  - 312a & 312b – new MASH end anchors
  - 321, 323, & 324 – changed the shape of the concrete barrier ties
  - 346, 346a, & 347 – new MASH CSF concrete median and safety barrier
  - 356 – transition end section for MASH barrier
  - 633, 637, & 637a – E-inlet modifications for CSF barrier

2018 Special Project Details

2018 Standard and Special Highway Drawing Index

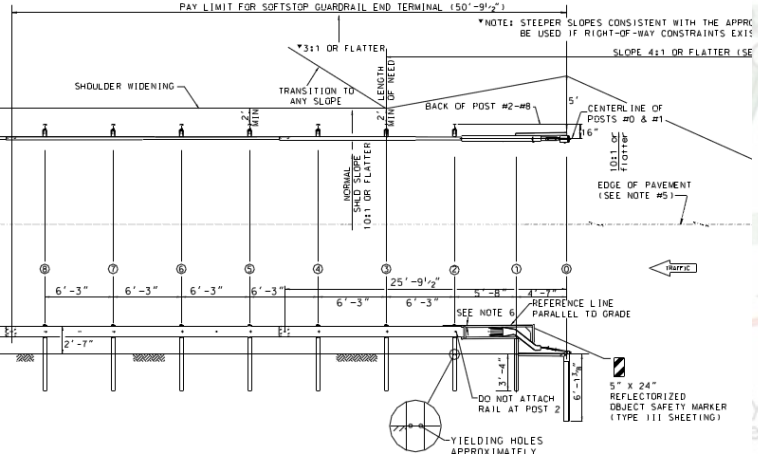
| | | | |
|---|---|---|---|
| 1 | SPD_0312a.pdf | Details of Guardrail End Anchors Series 20 (Softstop) (Mash) (Sheet 1 of 2) | 192KB |
| 2 | SPD_0312b.pdf | Details of Guardrail End Anchors Series 20 (MSKT) (Mash) (Sheet 2 of 2) | 144KB |
| 3 | SPD_0614.pdf | Sewer Inlet Type - B (Surface Drain) This Inlet is for use in Intersections and other locations where the surface type drain is required on the travelway | 131KB |
| 4 | SPD_0321.pdf | Details for Guardrail and Concrete Barrier Type 4A (Modified) At Culverts Where Shallow Fill Heights will not Accommodate Normal Posts | 238KB |
| 5 | SPD_0323.pdf | Flare Detail and Warranty Criteria for Beam Guardrail | 147KB |
| 6 | SPD_0324.pdf | Detail of Guardrail for Bridge Pier Protection on Existing Projects with Slopes Greater Than 10:1 | 127KB |
| 7 | SPD_0346_011618.pdf | Constant Slope Face Concrete Barrier (Flexible Pavement) (Sheet 1 of 2) | 151KB |
| 8 | SPD_0346a_011618.pdf | Constant Slope Face Concrete Barrier ( Rigid Pavement) (Sheet 2 of 2) | 154KB |
| 9 | SPD_0347.pdf | Constant Slope Face Barrier at Fixed Objects | 140KB |
| 10 | SPD_0356.pdf | Median Barrier Transitional End Section Type - T.E.S. | 81KB |
| 11 | SPD_0633.pdf | Details of Inlet - Type E-1 and E-2 for use with CSF-42 Concrete Median Barrier | 275KB |
| 12 | SPD_0637.pdf | Detail of Inlet- Type E-3 and E-4 for use with CSF-48 and CSF Concrete Median Barrier | 298KB |
| 13 | SPD_0637a.pdf | Detail of Precast Inlet Type E-3 and E-4 for use with CSF- 48 and CSF-54 Concrete Median Barrier | 173KB |
| 14 | SPD_1033_030618.pdf | Details Showing Application of Pavement Marker for 5-lane Roadways | 120KB |

# Design Requirements

- End anchor lengths : use 50 ft vs longest available
  - “Standard” practice in the past is to use 50’ length for Type 20 Series End Anchors. The Design Engineer suggests maintaining this practice.
  - If space is tight, consider the following:
    - SOFTSTOP pay length is 50’ – 9 ½” **TL-2 Version is ~ 38’**
    - MSKT pay length is 46’ – 10 ½”
    - MAX TENSION pay length is probably going to be 55’ – ½”

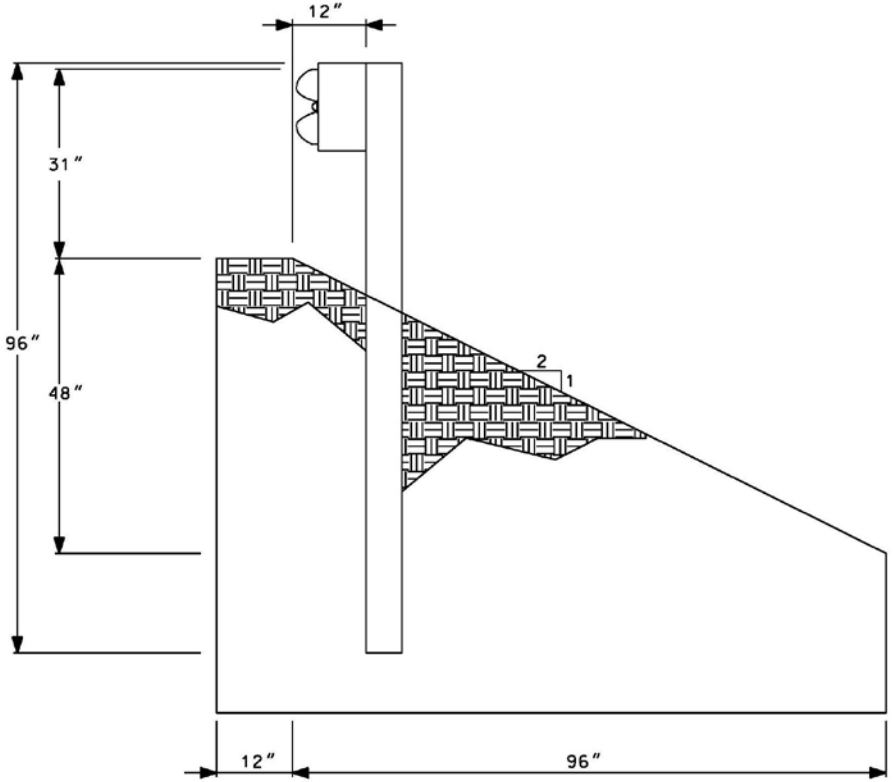
# Design Requirements

- TL-2 Availability and how to handle.
  - Only one ALDOT PEB approved TL-2 type 20 series end anchor (SOFTSTOP)
    - SOFTSTOP **TL-3** pay length is 50’ – 9 ½”
    - SOFTSTOP **TL-2** pay length is 38’ – 3 ½”
  - We have the drawing available and can provide upon request
  - Since there is only one be VERY careful calling for it in the plans
  - Really should only use where space is very tight and speed is 45mph or less



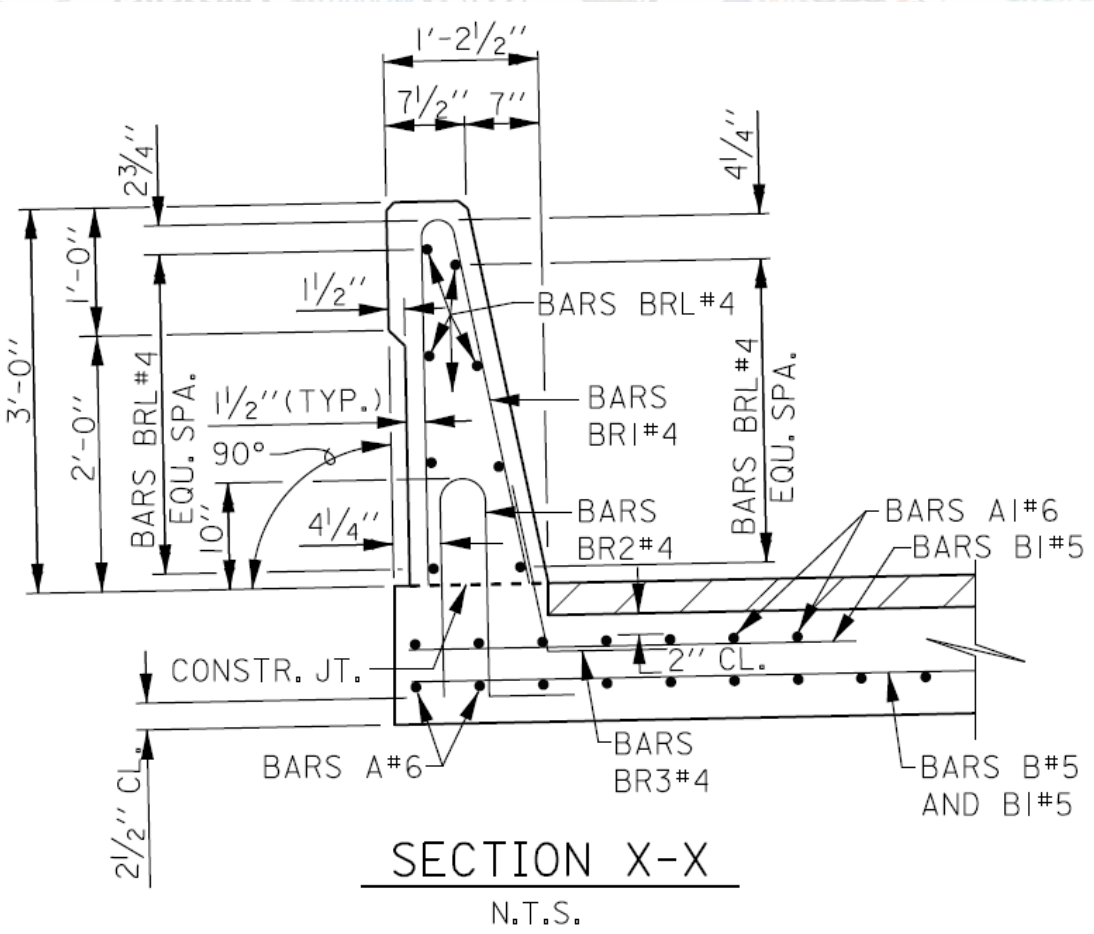
# Design Requirements

- Long post guardrail on slope
  - Approved for use where constrictions prohibit the widening of the slope
  - ALDOT approval date 11/17/2017 from the Design Engineer
- MASH specific pay items
  - To date there are MASH specific pay items for:
    - Type 20 Series Guardrail End Anchors
    - CSF Concrete Median or Safety Barrier



# Design Requirements

- Bridge Rail
  - MASH tested at 36” height
  - Guardrail is 31” height
  - Shortest CSF barrier is 42” height



# Questions?