NEW YORK STATE OF OPPORTUNITY. Department of Transportation	ENGINEERING INSTRUCTION	EI 17-008

Title: **RESTRICTIONS ON USE OF WEAK-POST W-BEAM, HPBO TERMINALS, AND HALF-SECTION CONCRETE BARRIER**

Approved: _____ 10/20/2017

Richard D. Wilder, P.E.
Deputy Chief Engineer (Design)

Date

ADMINISTRATIVE INFORMATION: SUPERSEDES EI 12-018

- Effective Date: For weak-post W-beam, this Engineering Instruction (EI) is effective beginning with projects submitted for the lettings on or after January 1, 2018. For generic Heavy-Post Blocked-Out W-Beam (HPBO) terminals, this EI is effective for projects with lettings on or after May 1, 2018.
- Where this EI and Highway Design Manual (HDM) Chapter 10 guidance on these devices differ, this EI shall prevail.
- Disposition of Materials: Final guidance will be incorporated into HDM Chapter 10.

PURPOSE: The purpose of this EI is to announce restrictions on the use of weak-post w-beam, HPBO terminals, and half-section concrete barrier.

TECHNICAL INFORMATION:

AASHTO/FHWA Joint Implementation Agreement for the Manual for Assessing Safety Hardware (MASH) - Restrictions Effective in 2018				
NYSDOT Safety Hardware	**MASH Compliance**		**Allowed on NHS and Freeways**	**Other Non-Freeway Highways**
	Deadline	**Authorized for Use?**		
HPBO Guide Rail	12/31/2017	Yes	Yes	Yes
HPBO Median Barrier	12/31/2017	Yes[1]	Yes	Yes
HPBO Terminals (Approved List)	6/30/2018	Yes	Yes	Yes
HPBO Terminals (Generic NYSDOT)	6/30/2018	No	No	Yes
Weak Post W-beam Guide Rail	12/31/2017	Yes[3]	No[3]	Yes
Weak Post W-beam Median Barrier	12/31/2017	No	No	Yes
Weak Post W-beam Approach End Turned Down Terminal	6/30/2018	No	No	No
SS Concrete Barrier (Cast-in-Place)	12/31/2017	Yes[1]	Yes	Yes
SS Concrete Barrier (Slip-Formed)	12/31/2017	Yes[1]	Yes	Yes
SS Concrete Barrier (Pre-cast)	12/31/2019	Yes[1]	Yes	Yes
SS Half-Section Barrier (Cast-in-Place)	12/31/2017	No[2]	No	Yes
SS Half-Section Barrier (Slip-Formed)	12/31/2017	No[2]	No	Yes
SS Half-Section Barrier (Pre-cast)	12/31/2019	No[2]	No	Yes

Notes:

1. Non-significant modification of a successfully MASH tested device.
2. Replace with full section concrete barrier where reasonable. Justify use where full section is not reasonable.
3. Authorized for use on all non-Freeway highways.

HPBO Systems

- HPBO roadside barrier may be used on all highways. Successful MASH testing and evaluation is documented in FHWA eligibility letter B-225.
- HPBO median barrier may be used on all highways. The Department has evaluated the system in accordance with the authority FHWA delegated and has determined that, compared to the HPBO roadside system that was crash tested to MASH, the modifications strengthen the system and it should perform as well or better. The MASH evaluation is documented in MA17-001 – Heavy Post Blocked-Out Median Barrier.
- The MSKT and SoftStop HPBO terminals are currently on NYSDOT's Approved List for Energy-Absorbing HPBO Terminals. Their MASH Eligibility Letters are as follows:
  - SoftStop - Eligibility Letter CC-115 (update of 11/12/15)
  - MSKT – Eligibility Letter CC126 SP-MGS and CC126E
- Flared-back, generic HPBO terminals are not to be included in PS&Es submitted for projects on the National Highway System (NHS) scheduled for letting on or after May 1, 2018. The energy-absorbing proprietary HPBO terminals on NYSDOT's Approved List should be used instead. However, NYSDOT's generic, flared-back, HPBO terminal may continue to be installed on non-NHS facilities that are also non-freeways.

Weak Post W-Beam

- New or replacement runs of weak-post, corrugated beam guide rail and median barrier shall not be placed on freeways.
- Weak-post, corrugated beam guide rail may be placed on non-freeway facilities.
- Successfully MASH tested HPBO terminals shall be used on corrugated beam guide rail and median barrier approach ends, and conventional, turned-down ends may only be installed on trailing ends.

Concrete Barriers

- Cast-in-Place and Machine-Formed single slope concrete barriers may be used on all highways. The Department has evaluated the systems in accordance with the authority FHWA delegated and determined that New York's modifications do not substantively alter the system behavior and that they should perform as well as or better than the successfully MASH tested system. The MASH evaluation is documented in MA17-002 – Cast-in-Place (and Machine-Formed) Concrete Barrier.
- Pre-cast single-slope concrete barriers may be used on all highways. The Department has evaluated the system in accordance with the authority FHWA delegated and determined that the modifications do not substantively alter the system behavior and that they should perform as well as or better than the successfully MASH tested concrete barrier system. The MASH evaluation is documented in MA17-003 – Precast Concrete Barrier.
- NYSDOT's use of permanent installations of Jersey-shape and F-shaped barriers essentially ceased a decade ago. Neither shape is to be used on NYSDOT's NHS highways.
- Half-section single-slope concrete barriers have not yet been crash tested. Until they have been successfully crash tested, their use should be avoided. If a situation arises where width restrictions require their use, such use shall be justified on a case-by-case basis.
- The testing deadline for temporary concrete barriers is December 31, 2019. This EI does not impact the continued use of TCB. Additionally, NYSDOT sponsored successful MASH testing of its temporary concrete barrier (Standard Sheet 619-01) in 2008 and obtained an FHWA Eligibility Letter for the system.

Bridge Barriers

- The deadline for bridge barriers is not until 12/31/2019. Therefore, bridge barriers, whether steel or concrete, are not addressed in this EI.

Maintenance Considerations

- A Transportation Maintenance Instruction (TMI) will be issued covering how repairs to the subject systems should be handled.

Cost Implications

- Where HPBO or box beam must be used instead of weak-post W-beam, the cost per run should approximately double. However, over the last four years, box has been used 13 times as much as weak post and HPBO has been used twice as much, so weak post is a relatively small portion of the guide rail placed.
- Generic, flared-back HPBO terminals are used infrequently and are only slightly less expensive than the shorter, currently available, proprietary terminals.

IMPLEMENTATION:

- For PS&Es submitted for letting on or after January 1, 2018, designers should make any alternate selections needed for weak-post W-beam run placements on affected projects prior to submission.
- For PS&Es submitted for letting on or after May 1, 2018, designers should incorporate any changes needed to prevent leading-end placement of weak-post W-beam terminals on affected projects prior to submission.

TRAMSMITTED MATERIALS:

- AASHTO/FHWA Joint Implementation Agreement for the AASHTO Manual for Assessing Safety Hardware, Approved December 21, 2015.
- Modification Analysis of a MASH-Certified Device MA 17-001 – Heavy Post Blocked-Out Median Barrier, dated October 19, 2017
- Modification Analysis of a MASH-Certified Device MA 17-002 – Cast-in-Place and Machine-Formed Concrete Barrier, October 19, 2017
- Modification Analysis of a MASH-Certified Device MA 17-003 – Precast Concrete Barrier, dated October 19, 2017

BACKGROUND: The "*AASHTO/FHWA Joint Implementation Agreement for the AASHTO Manual for Assessing Safety Hardware, 2015*" was approved on December 21, 2015. It should be noted that criteria referenced in the agreement as MASH 2015, are identical to the criteria noted as MASH 2016, as the Manual was not actually published until the spring of 2016. The Agreement places a series of deadlines on when different roadside barriers used on the NHS must be successfully crash tested to MASH. The first two deadlines affect only W-beam systems and Concrete barriers and are therefore the subject of this EI.

The agreement stipulates that, after December 31, 2017, only w-beam barriers and cast-in-place concrete barriers that have passed the 2015 MASH crash testing evaluation criteria will be allowed for new permanent installations and full replacements on the National Highway System. The deadline for W-beam terminals is June 30, 2018. Of the many proprietary and non-proprietary systems that sponsors are seeking to have tested, only a few have currently been tested. Consequently, uncertified systems will, for a year or two, not be permitted for installation on the NHS.

FHWA has delegated to the State DOTs the authority to approve non-significant modifications to successfully MASH-tested safety hardware devices. The analysis of proposed modifications to successfully MASH tested safety hardware for general and statewide use shall be prepared by or under the direction of the Department's subject matter experts and signed by the responsible licensed professional.

The Department plans to implement the agreement through a combination of measures including: validating its hardware against MASH by sponsoring crash testing, leveraging crash testing done by others, placing temporary or permanent restrictions on use of some safety hardware elements, and adopting new safety hardware as standards.

NYSDOT does not plan to test the weak-post terminal as an approach end under MASH. However, since weak-post runs passed both MASH TL-3 tests and have performed well, they may continue to be installed on non-freeway highways.

HPBO systems and proprietary terminals have been successfully crash tested, so they may be used. It is not anticipated that NYSDOT's flared-back generic HPBO terminal will be tested prior to the June 30, 2018 deadline for W-beam terminals.

CONTACT: Questions regarding this EI may be submitted to Terry Hale, PE, in the Design Quality Assurance Bureau via e-mail at Terry.Hale@dot.ny.gov or by calling (518) 485-7009.

AASHTO/FHWA Joint Implementation Agreement for the AASHTO Manual for Assessing Safety Hardware, 2015

Implementation of the 2015 edition of the AASHTO *Manual for Assessing Safety Hardware* (MASH) will be as follows:

- The AASHTO Technical Committee on Roadside Safety will continue to be responsible for developing and maintaining the evaluation criteria as adopted by AASHTO. FHWA will continue its role in issuing letters of eligibility of highway safety hardware for federal-aid reimbursement.
- Agencies are urged to establish a process to replace existing highway safety hardware that has not been successfully tested to NCHRP Report 350 or later criteria.
- Agencies are encouraged to upgrade existing highway safety hardware to comply with the 2015 edition of MASH either when it becomes damaged beyond repair, or when an individual agency's policies require an upgrade to the safety hardware.
- For contracts on the National Highway System with a letting date after the dates below, only safety hardware evaluated using the 2015 edition of MASH criteria will be allowed for new permanent installations and full replacements:
    - December 31, 2017: w-beam barriers and cast-in-place concrete barriers
    - June 30, 2018: w-beam terminals
    - December 31, 2018: cable barriers, cable barrier terminals, and crash cushions
    - 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
- Temporary work zone devices, including portable barriers, manufactured after December 31, 2019, must have been successfully tested to the 2015 edition of MASH. Such devices manufactured on or before this date, and successfully tested to NCHRP Report 350 or the 2009 edition of MASH, may continue to be used throughout their normal service lives.
- Regarding the federal-aid eligibility of highway safety hardware, after December 31, 2016:
    - FHWA will no longer issue eligibility letters for highway safety hardware that has not been successfully crash tested to the 2015 edition of MASH.
    - Modifications of eligible highway safety hardware must utilize criteria in the 2015 edition of MASH for re-evaluation and/or retesting.
    - Non-significant modifications of eligible hardware that have a positive or inconsequential effect on safety performance may continue to be evaluated using finite element analysis.

APPROVED DECEMBER 21, 2015

Modification Analysis of a MASH-Certified Device

MA 17-001 - *Heavy Post Blocked-Out (HPBO) Median Barrier*

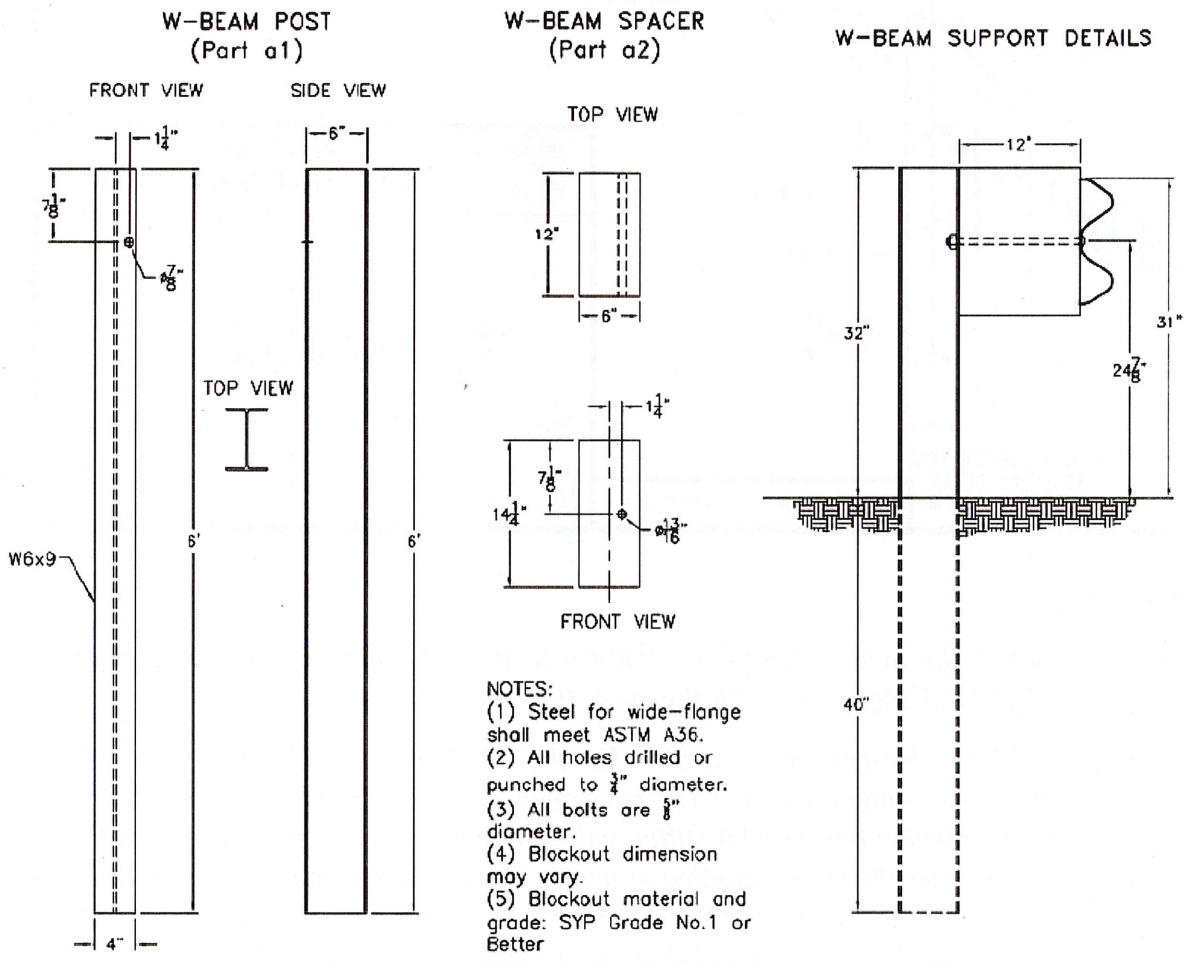
October 19, 2017

Purpose:

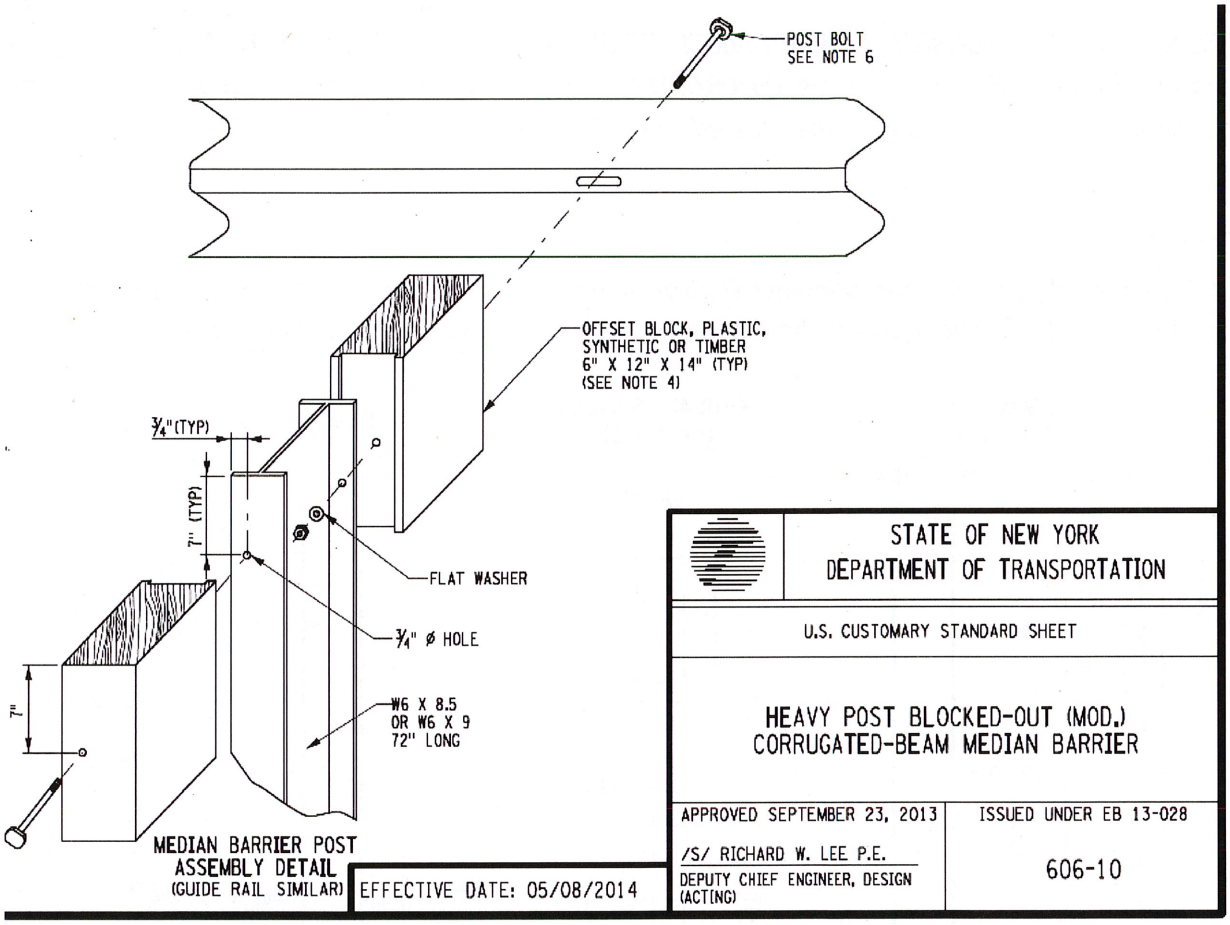
This purpose of this analysis is to determine if NYSDOT's Heavy Post Blocked-Out Median Barrier, on Standard Sheet 606-14, effective 05/08/2014, is a non-significant modification of a similar barrier that has been successfully crash tested to MASH 2016.

Description:

The MASH-tested barrier is the Midwest Guardrail System which was granted Eligibility Letter B-212 on June 10, 2011. The detail of the device, as depicted in that letter, is shown below.



The NYSDOT HPBO median barrier is based on the Midwest Guardrail System design. It has the same block-out and rail on both sides of the post so that it may perform as a median barrier. The detail of the NYSDOT design, as shown on Standard Sheet 606-10, effective 05/08/2014, is shown below.



Analysis Summary:

Height: *The height of the median barrier is identical to the MGS system, so there should be no concern over the height of engagement for the impacting test vehicles.*

Rail Strength: *The rail elements are identical for the MGS and the NYSDOT systems, so no difference in performance should be expected for similar stresses. However, the addition of the second rail makes the median barrier a bit stiffer, which means that the impact energy will need to be absorbed over a shorter distance, resulting in higher stresses in the rail. In service, there have been very few rail ruptures and all appear to have been with impact energies well above the energy used in a Tl-3 crash. Therefore, it is judged that the median barrier rail will be able to handle the stresses in a TL-3 without rupturing.*

Deflection: *Deflection is a concern both in terms of a vehicle deflecting the system enough to reach traffic on the other side of the barrier and in terms of the barrier deflecting enough for the impacting vehicle to contact the heavy post. Experience has shown that while larger vehicles may*

have the mass to deflect the system enough to contact the heavy posts, they also have sufficient mass to bend over or extract the heavy posts without causing severe decelerations to the occupants. Conversely, small vehicles typically do not have the impact energy to deflect the HPBO enough to contact the heavy posts, so there is not much chance of them experiencing severe longitudinal decelerations. In the case of median barrier, the extra stiffness provided by the second rail stiffens the median barrier system and further reduces the chances of a vehicle contacting the heavy post.

Conclusion:

The addition of a second rail and blockouts is considered a minor modification to the Midwest Guardrail system which has been successfully MASH tested, as indicated by the FHWA Eligibility Letter B-212. The systems are identical, except for the addition of the second rail and its blockouts. The modification has the same ability to capture impacting vehicles, has greater strength, and less deflection. For these reasons the New York State Department of Transportation judges the modification to be non-significant, and judges it to have inconsequential effect on safety performance. NYSDOT deems the HPBO median barrier to be acceptable for use on all highways in New York.

Prepared By:

Modification Analysis of a MASH-Certified Device

MA17-002 *Cast-In-Place Single-Slope Concrete Barrier*

October 19, 2017

Purpose:

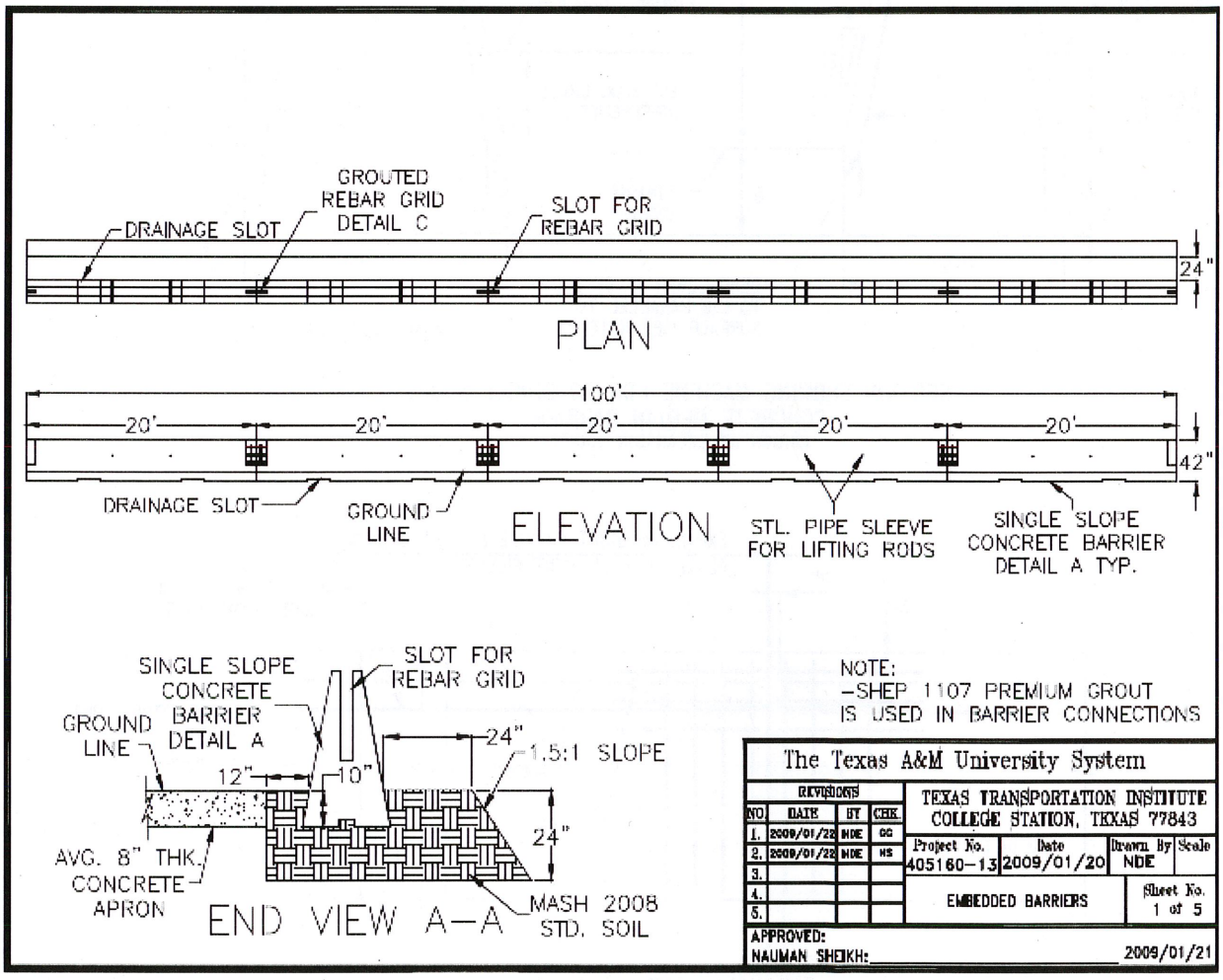
This purpose of this analysis is to determine if NYSDOT's Cast-In-Place (and Machine-Formed) Single-Slope Concrete Median Barrier, issued under EB 12-026 on Standard Sheet 606-14 is a non-significant modification of a similar device that has been successfully crash tested to MASH 2016.

Description:

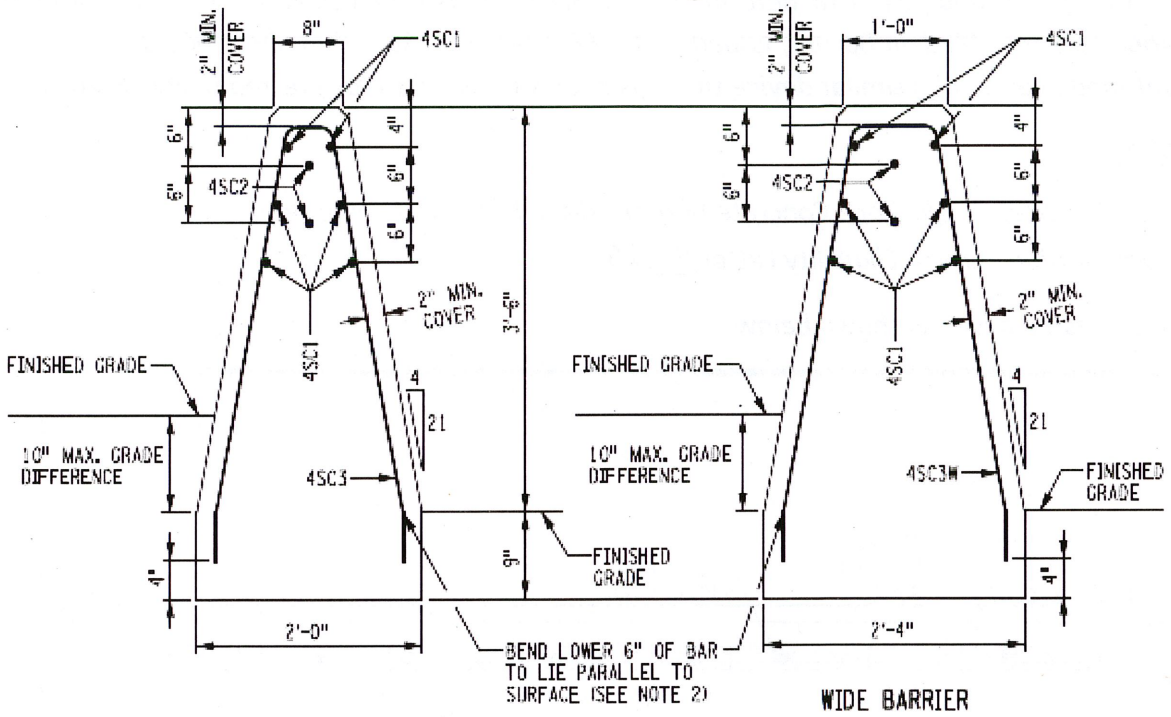
MASH-tested device: Single Slope Concrete Barrier Placed in front of steep slope

Test Documentation: FHWA Eligibility Letter B-225.

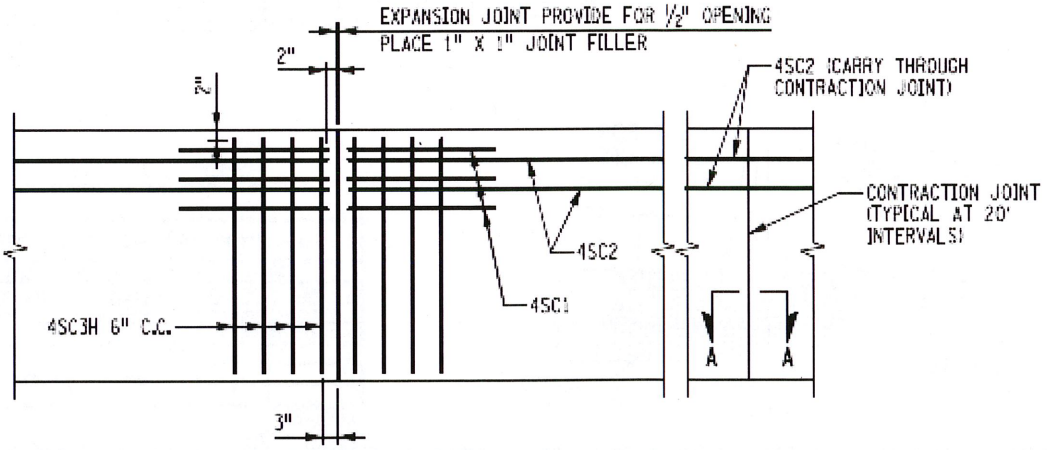
Detail of the tested device is shown below:



NYSDOT device (Machine-formed/slip-formed option shown):

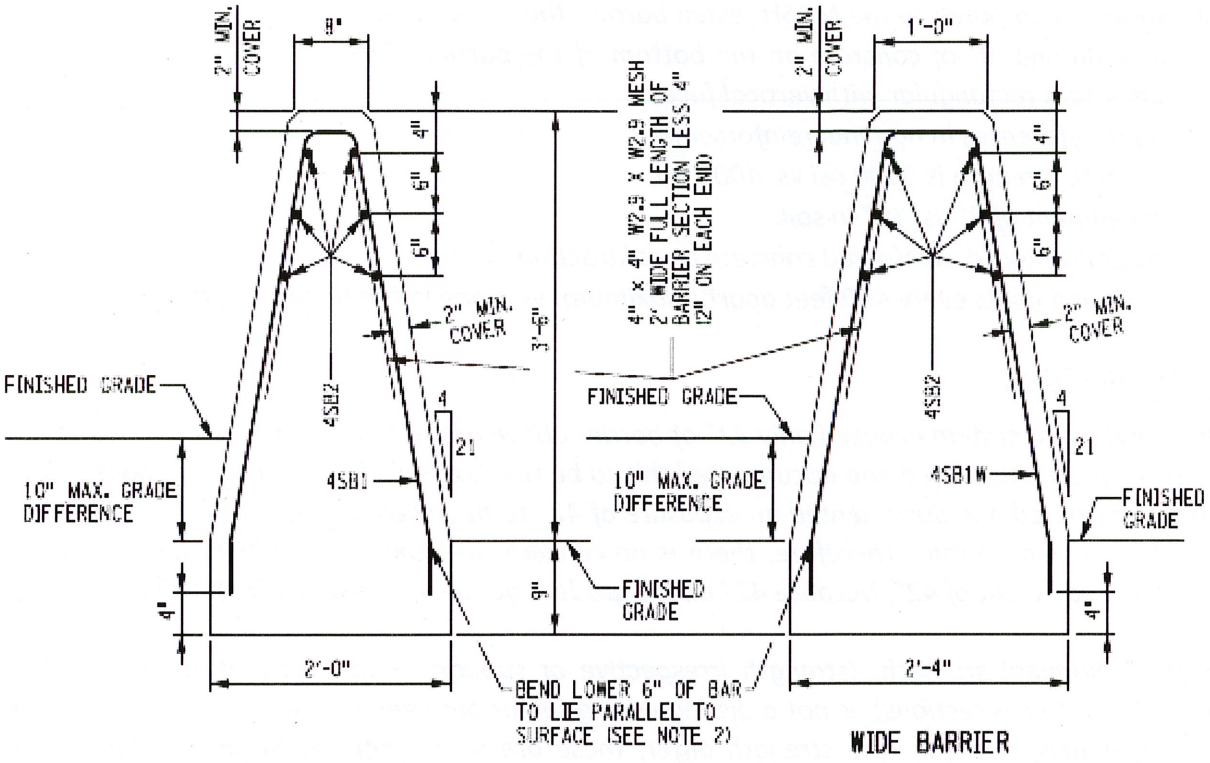


SECTION SHOWING MACHINE FORMED SINGLE-SLOPE
CONCRETE MEDIAN BARRIER
(SHOWN AT EXPANSION JOINT)

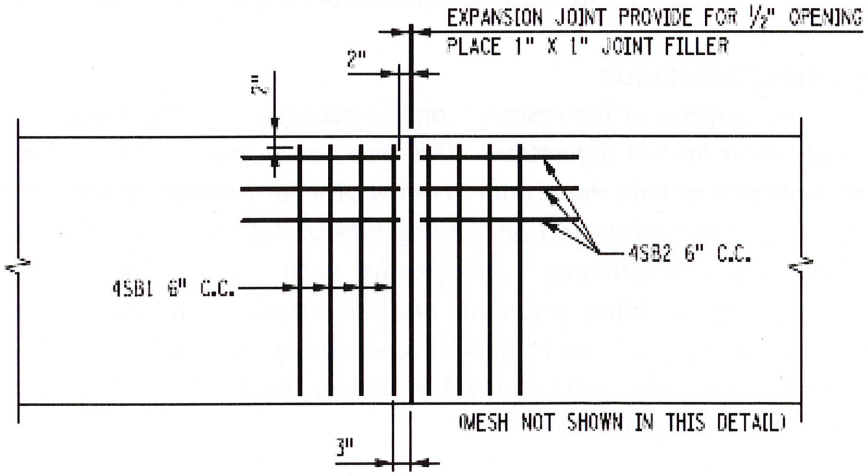


EXPANSION JOINT DETAIL
SHOWING REINFORCING BARS
FOR MACHINE FORMED SINGLE-SLOPE
CONCRETE HALF SECTION BARRIER

NYSDOT device (Cast-in-place option shown):



SECTION SHOWING CAST-IN-PLACE SINGLE-SLOPE
CONCRETE MEDIAN BARRIER
(SHOWN AT EXPANSION JOINT)



EXPANSION JOINT DETAIL
SHOWING REINFORCING BARS
FOR CAST-IN-PLACE SINGLE-SLOPE
CONCRETE MEDIAN BARRIER

Similarities between systems: *Each system is made of reinforced concrete with identical slope angles exposed to traffic. The gross cross section of both systems is identical for the top 42" of the barrier.*

Modifications: *Compared to the MASH tested barrier, the NYSDOT barrier has:*

- *An additional 9" of concrete on the bottom of the barrier. The cross section of the extra concrete is rectangular with vertical faces.*
- *Slight differences in nominal reinforcement.*
- *Concrete strength is 3000 psi vs. 4000 psi.*
- *Embedment of 9" vs. 10" in soil.*
- *Integrally placed, reinforced concrete at contraction joints.*
- *Expansion joints every 400 feet apart (maximum) vs. none in the tested length.*

Analysis Summary:

Height: *The tested system exposed only 32" of barrier above grade to the crash vehicle. However, the test evaluator considered and documented this to be the "extreme" case for the purposes of his test, and considered and documented an exposure of 42" to be acceptable and actually preferable with respect to vehicle roll. Therefore, there is no concern over the 51" height of the NY barrier with an exposed height of 42", because 42" above grade is actually considered preferable.*

"Strength:" *Nominal strength, (strength irrespective of support conditions and joints, which is discussed in following sections), is not a distinguishing factor between the two systems. While the reinforcing details, and concrete strength differ, these are not significant because extensive in-service performance of single-slope concrete barrier has established a legacy of high durability, and has proven concrete barriers to be nearly indestructible, except under the most catastrophic conditions. MASH test conditions do not approach the in-service extreme conditions for nominal strength that concrete barrier has endured in the field. Therefore, the modifications of concrete material properties (compressive strength) and nominal reinforcement details are not a concern.*

Deflection by Lateral Translation:

Tested system: *The purpose of the research on the successfully MASH tested system was to find a design that would limit lateral deflection. This was for a specific design need. The researchers found that soil embedment was the primary contributor for limiting lateral deflection. That is, the contribution of the grouted rebar grid on limiting lateral deflection was far more modest than the contribution from soil embedment. Specifically, with the grouted rebar grid and no soil embedment, (based on a finite element analysis model calibrated from bogie tests) the unembedded barrier was calculated to deflect upwards of 30". When the barrier was embedded 10" in the soil and crash tested with the MASH pickup truck vehicle, the actual lateral deflection was only 5 ½" quite reduced from 30+".*

NYSDOT System: *The NYSDOT system has integrally placed concrete and reinforcing extending through each contraction joint location, so the detail should offer greater strength than the closure pour used in the tested system. Additionally, the NY barrier, which has 24% more mass because of its increased height, has substantially increased lateral resistance through its own inertia. Most*

critically, with nearly two decades of in-service performance and hundreds of impacts, no instances of deflection at the base have been reported. NYSDOT has a seldom used, wide version of its single-slope barrier, also shown on Standard Sheet 606-14. The extra width contributes both to greater strength and greater mass, making it even less likely to translate or lean.

*Embedment is 9" in the NYSDOT system vs. 10" in the tested system. NYSDOT practice for concrete median barriers is to pave up to the barrier on both sides and to place a resilient joint filler against the toe to mitigate pavement expansion and crushing risks. The guidance is in HDM Section 3.2.7, which states, "*The entire area between the traveled way and the base of the concrete barrier should be paved to at least the thickness of the adjoining shoulder.*" The MASH-tested system had only soil embedment and only for a limited lateral extent as an over-steepened slope (1.5:1) began just 2 feet behind the barrier. NYSDOT's concrete median barriers are therefore much better locked in place than was the case with the soil embedment of the tested article.*

It is also noteworthy that minor deflection without lean is not a concern for NYSDOT median barriers, as there should always be a minimum of two feet of offset between the traveled way and a permanent concrete barrier. The deflection constraint for NYSDOT median barriers is based on the need to separate opposing traffic. The most critical (narrow median) installation could easily accommodate more than 5½" of deflection without interfering with traffic in opposing travel lanes. The successfully MASH tested system had a specific need for limited deflection on top of a retaining wall system.

Furthermore, the MASH test results demonstrate the system's suitability for roadside use. With the greater mass of the NYSDOT concrete barrier, deflections should be less than were experienced in the test conditions. Therefore, from a lateral deflection perspective, the NYSDOT concrete barrier should be capable of passing MASH testing when used with two or more feet of soil before a slope break to a 1.5:1 slope.

For the above reasons, lateral deflection without lean is not a concern for the NY barrier.

Snagging:

In theory, snagging could occur if one section of barrier leans and the next piece does not also lean a similar amount. In the successfully MASH tested system, no expansion joints were modeled and adjacent precast sections were made continuous by placing and grouting rebar grids in end slots of the precast sections. The rebar grids span the joints between the sections. During the crash testing, the precast sections remained continuous, providing no opportunity for the test vehicle to be snagged by a protruding edge.

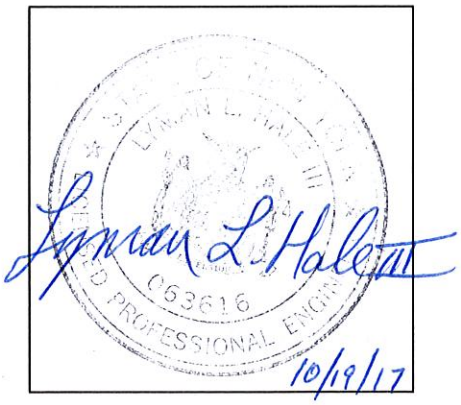
In the NYSDOT system, the connection through the contraction joints defining adjacent "pieces" is a continuous concrete pour with reinforcement. That will provide better shear resistance against the barrier leaning. Additionally, the NYSDOT system is more massive than the system described in B-225. Finally, NYSDOT has used the single-slope system for nearly two decades. During that time,

not a single instance of snagging due to barrier lean has been reported, despite the system having been struck many hundreds of times. Additionally, there have also been no reports of the system experiencing lean due to impacts.

Conclusion:

NYSDOT has Cast-In-Place and Machine-Formed (Slip-Formed) Single-Slope Concrete Median Barriers, shown on NY Standard Sheet 606-14, that it has evaluated as minor modifications of the MASH tested "Single Slope Concrete Barrier Placed in Front of Steep Slope" described in FHWA Eligibility Letter B-225. The effects of the differences have been analyzed, are considered non-significant, and are judged to have inconsequential effect on safety performance. Therefore, NYSDOT considers its 42" Single-Slope Concrete Median Barrier to be acceptable for use as both roadside and median barrier on all highways in New York when constructed by either cast-in-place or slip-formed methods.

Prepared By:



Modification Analysis of a MASH-Certified Device

MA17-003 Precast Single-Slope Concrete Barrier

October 19, 2017

Purpose:

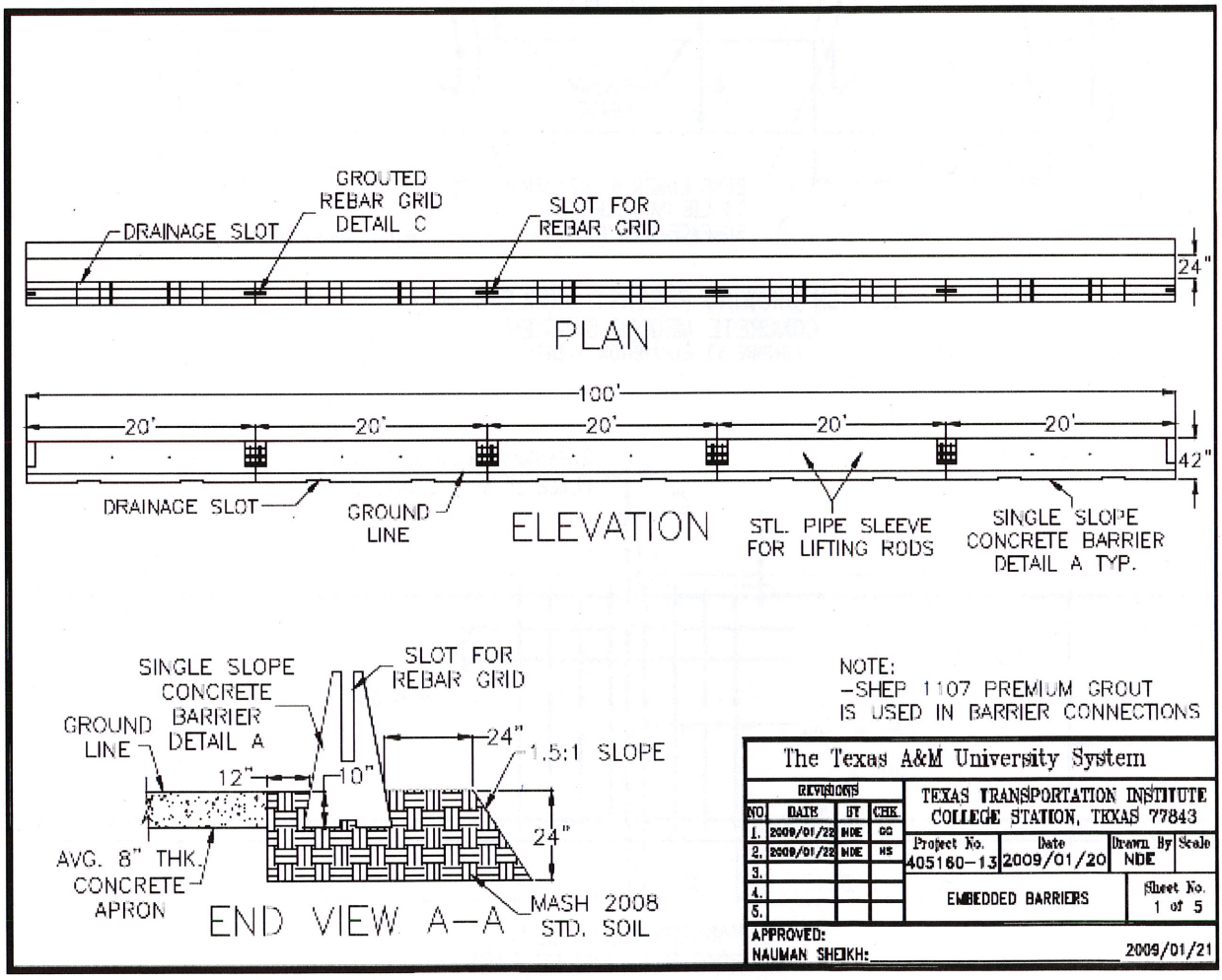
This purpose of this analysis is to determine if NYSDOT's Precast Single-Slope Concrete Median Barrier, issued under EB 12-026 on Standard Sheet 606-14 is a non-significant modification of a similar device that has been successfully crash tested to MASH 2016.

Description:

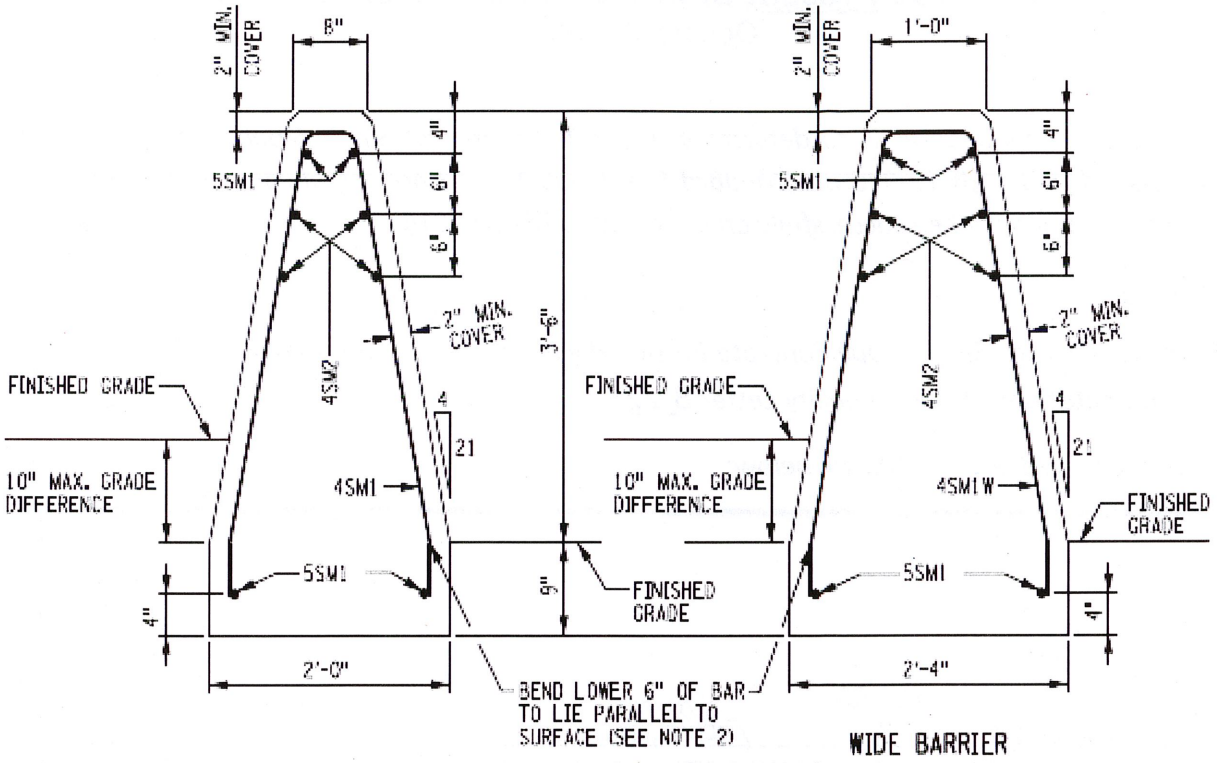
MASH-tested device: Single Slope Concrete Barrier Placed in front of steep slope

Test Documentation: FHWA Eligibility Letter B-225.

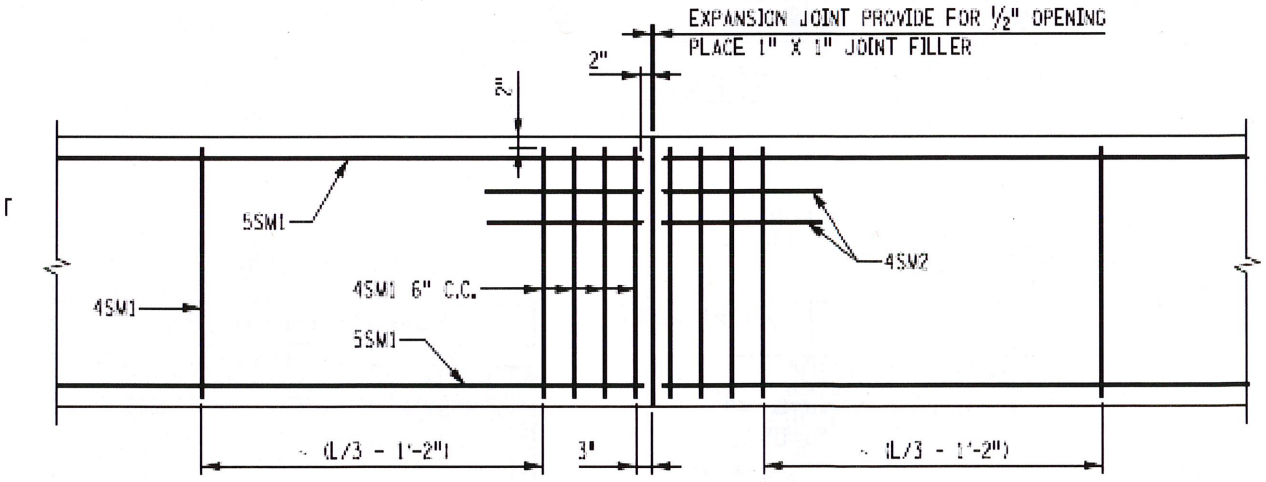
Detail of the tested device is shown below:



NYSDOT device (precast option shown):



SECTION SHOWING PRECAST SINGLE-SLOPE CONCRETE MEDIAN BARRIER
(SHOWN AT EXPANSION JOINT)



EXPANSION JOINT DETAIL SHOWING REINFORCING BARS FOR PRECAST SINGLE-SLOPE CONCRETE MEDIAN BARRIER

Similarities between systems: *Both systems are made of reinforced concrete with identical slope angles exposed to traffic. The gross cross section of both systems is identical for the top 42" of the barrier. Nominal length of precast sections is 20 feet for both systems.*

Modifications: *Compared to the MASH tested barrier, the NYSDOT barrier has:*

- *An additional 9" of concrete on the bottom of the barrier. The cross section of the extra concrete is rectangular with vertical faces.*
- *Slight differences in nominal reinforcement.*
- *Concrete strength is 3000psi vs. 4000 psi*
- *Soil embedment of 9" vs. 10"*
- *No positive connection (grouted rebar grid) between precast units.*

Analysis Summary:

Height: *The tested system exposed only 32" of barrier above grade to the crash vehicle. However, the test evaluator considered and documented this to be the "extreme" case for the purposes of his test, and considered and documented an exposure of 42" to be acceptable and actually preferable with respect to vehicle roll. Therefore, there is no concern over the 51" height of the NY barrier with an exposed height of 42", because 42" above grade is actually considered preferable.*

"Strength:" *Nominal strength, (strength irrespective of support conditions and joints, which is discussed in following sections), is not a distinguishing factor between the two systems. While the reinforcing details, and concrete strength differ, these are not significant because extensive in-service performance of single-slope concrete barrier has established a legacy of high durability, and has proven concrete barriers to be nearly indestructible except under the most catastrophic conditions. MASH test conditions do not approach the in-service extreme conditions for nominal strength that concrete barrier has endured in the field. Therefore, the modifications of concrete material properties (compressive strength) and nominal reinforcement details is not a concern.*

Deflection by Lateral Translation:

Tested system: *The purpose of the research on the successfully MASH tested system was to find a design that would limit lateral deflection. This was for a specific design need. The researchers found that soil embedment was the primary contributor for limiting lateral deflection. That is, the contribution of the grouted rebar grid on limiting lateral deflection was far more modest than the contribution for soil embedment. Specifically, with the grouted rebar grid and no soil embedment, (based on a finite element analysis model calibrated from bogie tests) the unembedded barrier was calculated to deflect upwards of 30". When the barrier was embedded 10" in the soil and crash tested with the MASH pickup truck vehicle, the actual lateral deflection was only 5 ½" quite reduced from 30+".*

NYSDOT System: *The NYSDOT system has no positive connection between precast units, so the resistance to lateral movement provided by the grouted rebar grid in the certified system is not*

present in the NY system. However, the NY barrier, which has 24% more mass because of its increased height, has substantially increased lateral resistance through its own inertia. NYSDOT has a seldom used wide version of its single-slope barrier, also shown on Standard Sheet 606-14. The extra width contributes both to greater strength and greater mass, making it even less likely to translate or lean.

*Embedment is 9" in the NYSDOT system vs. 10" in the tested system. NYSDOT practice for concrete median barriers is to pave up to the barrier on both sides and to place a resilient joint filler against the toe to mitigate pavement expansion and crushing risks. The guidance is in HDM Section 3.2.7, which states, "*The entire area between the traveled way and the base of the concrete barrier should be paved to at least the thickness of the adjoining shoulder.*" The MASH-tested system had only soil embedment and only for a limited lateral extent as an over-steepened slope (1.5:1) began just 2 feet behind the barrier. NYSDOT's concrete median barriers are therefore much better locked in place than was the case with the soil embedment of the tested article.*

It is also noteworthy that minor deflection without lean is not a concern for NYSDOT median barriers, as there should always be a minimum of two feet of offset between the traveled way and a permanent concrete barrier. The deflection constraint for NYSDOT median barriers is based on the need to separate opposing traffic. The most critical (narrow median) installation could easily accommodate more than 5½" of deflection without interfering with traffic in opposing travel lanes. The successfully MASH tested system had a specific need for limited deflection on top of a retaining wall system.

Furthermore, the MASH test results demonstrate the system's suitability for roadside use. With the greater mass of the NYSDOT concrete barrier, deflections should be less than were experienced in the test conditions. Therefore, from a lateral deflection perspective, the NYSDOT concrete barrier should be capable of passing MASH testing when used with two or more feet of soil before a slope break to a 1.5:1 slope.

For the above reasons, lateral deflection without lean is not a concern for the NY barrier.

Snagging:

In theory, snagging could occur if one section of barrier leans and the next piece does not also lean a similar amount. In the successfully MASH tested system, no expansion joints were modeled and adjacent precast sections are made continuous by placing and grouting rebar grids in end slots of the precast sections. The rebar grids span the joints between the sections. During the crash testing, the precast sections remained continuous, providing no opportunity for the test vehicle to be snagged by a protruding edge.

In the NYSDOT system, the only connection between adjacent pieces is a continuous 1" x 1" expansion joint filler compressed to a nominal ½" width. That may not provide much shear resistance against the barrier leaning. However, the NYSDOT system is more massive than the

system described in B-225. NYSDOT has used the single-slope system for nearly two decades. During that time, no reports of the system experiencing lean or snagging due to barrier lean has been reported, despite the system having been struck many times.

Conclusion:

NYSDOT has a Precast Single-Slope Concrete Median Barrier, shown on NY Standard Sheet 606-14, that it has evaluated as a minor modification of the MASH-tested "Single Slope Concrete Barrier Placed in Front of Steep Slope" described in FHWA Eligibility Letter B-225. The effects of the differences have been analyzed, are considered non-significant, and are judged to have inconsequential effect on safety performance. Therefore, NYSDOT considers its precast 42" Single-Slope Concrete Median Barrier to be acceptable for use as both roadside and median barrier on all highways in New York.

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