

## TRANSPORTATION RESEARCH SYNTHESIS

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# Use of Positive Protection in Work Zones

*Prepared by CTC & Associates LLC*

The MnDOT Office of Traffic, Safety and Technology is developing a manual on the use of temporary barriers, truck-mounted attenuators and other types of positive protection devices as guidance for designers, construction workers and contractors. To support the development of this manual, MnDOT is interested in gathering information about best practices for positive protection in work zones used by other state departments of transportation (DOTs).

This Transportation Research Synthesis presents the results of a survey distributed to members of the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Construction about their DOT's policies and practices for positive protection in work zones. It also includes findings from a literature search that focused on obtaining links to positive protection manuals, guidance and specifications from other DOTs.



## **Technical Advisory Panel**

**Jeffrey Morey**, Technical Liaison  
MnDOT Office of Traffic, Safety and Technology

**Wes Alwan**, Principal Investigator  
CTC & Associates LLC

**Mark Linsenmayer**, Principal Investigator  
CTC & Associates LLC

**Dan Warzala**, Project Coordinator  
MnDOT Research Services & Library

**Kenneth Johnson**, Panelist  
MnDOT Office of Traffic, Safety and Technology

**Ethan Peterson**, Panelist  
MnDOT Office of Traffic, Safety and Technology

*The purpose of this Transportation Research Synthesis (TRS) is to serve as a synthesis of pertinent completed research to be used for further study and evaluation by MnDOT. This TRS does not represent the conclusions of either the authors or MnDOT.*

# Use of Positive Protection in Work Zones

## Introduction

The MnDOT Office of Traffic, Safety and Technology is developing a manual on the use of temporary barriers, truck-mounted attenuators and other types of positive protection devices as guidance to be used by designers, construction workers and contractors. To support the development of this manual, MnDOT is interested in gathering information on best practices for positive protection in work zones used by other state departments of transportation (DOTs). To help with this task, an online survey was distributed to members of the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Construction about their DOT's policies and practices for positive protection in work zones. A literature search was also conducted, with a focus on obtaining links to positive protection manuals, guidance and specifications from other DOTs.

## Summary of Findings

This Transportation Research Synthesis is divided into four sections:

- Survey of State Transportation Agencies.
- State Resources.
- National Resources.
- Related Research and Other Resources.

## Survey of State Transportation Agencies

An online survey concerning policies for positive protection in work zones was distributed to members of the AASHTO Subcommittee on Construction. Nineteen state DOTs responded to the survey. Key findings of the survey are given below:

1. **Documentation:** Most states provided documentation on positive protection. Seven states— California, Massachusetts, Minnesota, Nebraska, North Dakota, South Carolina and Wyoming—did not provide documentation.
2. **Allowances behind temporary barrier:** Six DOTs have allowances. Arkansas, Michigan and Virginia provided links to guidance. In New Hampshire, anything less than a 2-foot deflection will require a restrained portable concrete barrier (PCB) system to minimize deflection. South Carolina only requires anchorage on bridge decks with 8 feet or less of space between the edge of the unprotected bridge deck and the near edge of the barrier wall.
3. **Surface under temporary barrier:** Most states require pavement under temporary barriers. Michigan, Montana and North Dakota allow these barriers to be used on gravel in some circumstances.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: Typically 2 feet (six states) or 4 feet (four states).
  - b. Anchored/protection: Typically 0 feet (three states), 1 foot (three states) or 2 feet (two states).
  - c. Unanchored/severe drop-off: Typically 2 feet (four states) or 4 feet (three states). South Carolina specifies 8 feet.

- d. Anchored/severe drop-off: Varies, ranging from 0 to 6 feet. Three states specify 1 foot.
- e. Explanation of temporary barriers/anchors used: Most states provided guidance.
- 5. **Overlap:** Most states allow overlap in some circumstances.
- 6. **Head-to-head protection:** Some states use a temporary barrier for head-to-head protection.
- 7. **Criteria for temporary barrier use:** Most states provided links to guidance or specified criteria.
- 8. **Installation near curb:** Some states place the barrier at a distance from the curb, while other states place the barrier flush with or on top of the curb.
- 9. **Clear zone distance in work zones:** Eleven DOTs have a simple clear zone distance in work zones.
- 10. **Alternatives to anchoring portable concrete barriers:** Eight states do not have alternatives to anchoring. Michigan uses box beam stiffeners, New Hampshire uses PCB braced barriers, Texas uses an X-bolt barrier, and Virginia uses sand bags. Nebraska typically provides enough space behind barriers to avoid anchoring them into new pavements or bridge decks, and South Carolina does not anchor barriers on new pavements. Wisconsin is currently researching a crashworthy low-deflection barrier system.

### **State Resources**

The literature review provided positive protection documentation from six states—Colorado, Idaho, New York, North Carolina, Oregon and Texas—that did not respond to the survey.

### **National Resources**

Several national resources address positive protection documentation, including the following:

- The Federal Highway Administration (FHWA) work zone traffic management Web page contains links to resources for work zone traffic management, including positive protection.
- A 2009 FHWA handbook includes information on positive protection traffic control devices, and a 2013 FHWA guide includes practices for effectively managing work zones.
- A 2006 NCHRP report provides strategies that can be employed to reduce work zone crashes.

### **Related Research and Other Resources**

The literature search produced a number of other resources related to positive protection in work zones:

- A 2015 guide from the American Traffic Safety Services Association examines types of positive protection devices.
- A 2014 Kansas study provides a synthesis of devices and state of the practice.
- An ongoing NCHRP study is developing comprehensive guidance on the characteristics of work zone crashes and the effectiveness of various countermeasures.

## **Next Steps**

MnDOT should consider:

- Analyzing documentation provided by survey respondents, with a view to establishing guidelines for use in Minnesota.
- Following up with states, where applicable, for further information on allowances, deflection spaces and criteria for temporary barrier use.
- Following up with states about alternatives to portable barriers, including Texas' X-bolt barrier, Michigan's use of box beam stiffeners and New York State's system.

## **Detailed Findings**

### **Survey of State Transportation Agencies**

An online survey was distributed to members of the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Construction concerning their department of transportation's (DOT's) policies for positive protection in work zones. The survey consisted of the following questions:

1. Does your agency have a manual or other documentation regarding its use of temporary barriers and other positive protection devices in work zones? If so, please provide a link to this documentation.
2. To prevent damage to new pavements, MnDOT will usually anchor a portable concrete barrier (PCB) when there is less than 2 feet behind the barrier to a drop-off. However, MnDOT occasionally encounters construction staging that results in a tight cross section on new pavement with less than 2 feet of pavement surface available behind the PCB. Does your agency have any time-sensitive or length-sensitive allowances behind the temporary barrier if minimal deflection distances are not attainable without anchoring? If yes, please describe these allowances.
3. As stated previously, MnDOT will usually anchor a PCB when there is less than 2 feet behind the barrier to a drop-off. Does your agency require that the surface under a temporary barrier and your agency's deflection distance be pavement? For example, would your agency allow the placement of a temporary barrier on aggregate base or on dirt? Does a compacted gravel base in the deflection area act appropriately?
4. What deflection space behind a temporary barrier do you require for the following cases:
  - a. Unanchored and not providing protection from a severe drop-off (a severe drop-off is considered to be similar to a bridge with the exterior barrier removed, a significant subcut or the top of a retaining wall).
  - b. Anchored and not providing protection from a severe drop-off.
  - c. Unanchored with a severe drop-off.
  - d. Anchored with a severe drop-off.
  - e. Please provide an explanation of the types of temporary barriers and anchors you use (such as a bituminous pin or adhesive anchor system).
5. Does your agency overlap temporary barriers past other temporary or permanent barriers or guardrails instead of attaching them? If so, how long does the overlap need to be?
6. When does your agency use a temporary barrier for "head-to-head" protection, and does your agency have guidance for its use? Please provide a link to this guidance.
7. Installation of a temporary barrier takes time and a temporary traffic control operation is needed for its installation and removal, which also exposes workers to hazards during the installation and removal process. Examples of criteria include type of work and length of exposure to hazards. What criteria does your agency use to determine the use of a temporary barrier?
8. How does your agency install a temporary barrier near a curb?
9. Does your agency have a simple clear zone distance in work zones that differs from permanent clear zone distances? If yes, what is the distance?
10. MnDOT is looking for alternatives to anchoring PCBs in new pavements when deflection space is limited, such as using two runs of PCBs side by side instead of anchoring one run (and perhaps filling in the area

between the barrier runs to make it more rigid). Please describe any systems or methods that your agency uses to avoid anchoring.

### **Survey Responses by State**

Nineteen state DOTs responded to the survey. Summaries of survey results are provided below, organized by state. For reference, an abbreviated version of each question is included before the response. Responses have been edited for clarity.

#### **Arkansas**

Contact: Chuck Martin, Assistant Division Head, Roadway Division, Arkansas State Highway and Transportation Department, 501-569-2336, [Chuck.Martin@ahtd.ar.gov](mailto:Chuck.Martin@ahtd.ar.gov).

1. **Documentation:** [http://www.arkansashighways.com/roadway\\_design\\_division/usunits/usunit.aspx](http://www.arkansashighways.com/roadway_design_division/usunits/usunit.aspx)
2. **Allowances behind temporary barrier:** Yes. Refer to standard drawing TC-5 in the link provided above.
3. **Surface under temporary barrier:** Would need to be pavement so that the anchor would be effective.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: [No response.]
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: [No response.]
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: Refer to standard drawing.
5. **Overlap:** Not as standard practice. If it were to be done it would be the distance necessary to protect, or a 50 foot minimum.
6. **Head-to-head protection:** We utilize this configuration on interstate rehabilitation projects where one set of lanes is closed on a four lane divided freeway.
7. **Criteria for temporary barrier use:** MUTCD [Manual on Uniform Traffic Control Devices], AASHTO Roadside Design Guide.
8. **Installation near curb:** Refer to standard drawing.
9. **Clear zone distance in work zones:** No.
10. **Alternatives to anchoring PCBs:** [No response.]

#### **California**

Contact: Samir Ead, Safety Coordinator, Construction, California Department of Transportation, 916-654-4580, [Samir.Ead@dot.ca.gov](mailto:Samir.Ead@dot.ca.gov).

1. **Documentation:** No, Caltrans does not have a manual for temporary barriers.
2. **Allowances behind temporary barrier:** No.
3. **Surface under temporary barrier:** K rail must be supported by at least 4 inches thick concrete, hot mix asphalt or existing asphalt concrete pavement.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 4 feet.
  - b. Anchored/protection: 2 feet.

- c. Unanchored/severe drop-off: 4 feet.
- d. Anchored/severe drop-off: 2 feet.
- e. Explanation of temporary barriers/anchors used: K-Rail—24 inches capped stake.
- 5. **Overlap:** Overlap by 20 feet (1 stick min).
- 6. **Head-to-head protection:** Design is working to develop some criteria.
- 7. **Criteria for temporary barrier use:** Design is still working on the criteria.
- 8. **Installation near curb:** [No response.]
- 9. **Clear zone distance in work zones:** No.
- 10. **Alternatives to anchoring PCBs:** [No response.]

### ***Delaware***

Contact: Adam Weiser, Safety Programs Manager, Traffic Section, Division of Transportation Solutions, Delaware Department of Transportation, 302-659-4073, [Adam.Weiser@state.de.us](mailto:Adam.Weiser@state.de.us).

- 1. **Documentation:**
  - a. Yes, we created a Design Guidance Memorandum in response to the Final Rule on Temporary Traffic Control Devices. [http://www.deldot.gov/information/pubs\\_forms/manuals/dgm/pdf/1-21\\_use\\_temp\\_traffic\\_barrier\\_wz.pdf](http://www.deldot.gov/information/pubs_forms/manuals/dgm/pdf/1-21_use_temp_traffic_barrier_wz.pdf)
  - b. Also, please see the Delaware MUTCD, specifically Part 6 and Section 6F.85. [www.mutcd.deldot.gov](http://www.mutcd.deldot.gov)
- 2. **Allowances behind temporary barrier:** No.
- 3. **Surface under temporary barrier:** We require that the barrier be placed on a paved surface as that is how the barrier has been tested. This is not reflected in our current Design Guidance but is a state of the practice. The Design Guidance will be updated soon.
- 4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 4 feet.
  - b. Anchored/protection: 0 feet.
  - c. Unanchored/severe drop-off: Unspecified (evaluated on a case-by-case basis).
  - d. Anchored/severe drop-off: 0 feet (can be more on a case-by-case basis).
  - e. Explanation of temporary barriers/anchors used: We require NCHRP-350/MASH tested systems that utilize pins in either asphalt or concrete.
- 5. **Overlap:** Yes. Depends on the system that is being overlapped. It is a function of the design deflection of the system. For example, if overlapping behind guardrail, the end of the barrier must be more than 4 feet away from the guardrail to account for guardrail deflection. We have moved away from this and are now requiring guardrail-to-barrier connections in most cases.
- 6. **Head-to-head protection:** We rarely use barrier for head-to-head protection mainly due to space constraints. Typically use is based on speed of traffic. We require it on limited access high speed highways. Case-by-case on other roadways.
- 7. **Criteria for temporary barrier use:** See provided Design Guidance and DE [Delaware] MUTCD regarding criteria for use. Generally, use is based on proximity to high speed traffic, traffic volumes, type, location and duration of work activities, lack of escape route for workers and protection of fixed objects/work activities.
- 8. **Installation near curb:** Typically, the barrier is placed against the face of the curb.
- 9. **Clear zone distance in work zones:** Yes. See DE MUTCD, Table 6G-1 related to vertical differences.



10. **Alternatives to anchoring PCBs:** None at this time. We are aware of a NYDOT crash tested system that utilizes box beam guardrail elements on the work zone side of the barrier to provide stiffening. We have considered the use of such a system but have not done so yet. PennDOT also has tested something similar.

### **Florida**

Contact: Daniel Strickland, Professional Engineer III, Office of Construction, Florida Department of Transportation, 850-414-4352, [Daniel.Strickland@dot.state.fl.us](mailto:Daniel.Strickland@dot.state.fl.us).

1. **Documentation:**
  - a. Plans Preparation Manual (PPM) Chapter 4.4  
<http://www.fdot.gov/roadway/PPMManual/2017/Volume1/Chap04.pdf>
  - b. Design Standards, Index 412, 414, 415 and 600 <http://www.fdot.gov/roadway/DS/18/STDs.shtm>
  - c. Standard Specifications, Section 102-9  
<http://www.fdot.gov/programmanagement/Implemented/SpecBooks/January2017/Files/117eBook.pdf>
2. **Allowances behind temporary barrier:** No.
3. **Surface under temporary barrier:** When pavement does not exist, FDOT requires a temporary 2 inch asphalt pad installed in accordance with Standard Spec 339.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 2 feet minimum.
  - b. Anchored/protection: 1 foot minimum.
  - c. Unanchored/severe drop-off: 4 feet minimum.
  - d. Anchored/severe drop-off: 1 foot minimum (even less if bolted on bridges).
  - e. Explanation of temporary barriers/anchors used: 32" F Shape 12.5 feet long with 3'4" asphalt stakes or bridge deck bolts.
5. **Overlap:** Yes, FDOT allows overlapping which is typically 6 units (12.5' long) totaling approximately 72 feet (see Design Standards, Index 415, Sheets 5 and 6 for other options).
6. **Head-to-head protection:** Assuming you are referring to placing the barrier between opposing lanes of traffic, then yes but they are not permitted to be anchored (see Design Standards, Index 414 and 415).
7. **Criteria for temporary barrier use:** FDOT doesn't have specific guidance for the use of barriers to provide positive protection solely to protect workers, but guidance is provided for when barriers are required to protect motorists [from] hazards (reference PPM Ch. 4.4 and Design Standards, Index 600).
8. **Installation near curb:** Only if there is enough deflection space between the barrier and curb as outlined in our Design Standards.
9. **Clear zone distance in work zones:** Yes. Reference Table 4.2.1 and 4.2.2 in Chapter 4 of the PPM.
10. **Alternatives to anchoring PCBs:** FDOT does not have un-anchored alternative to our standard deflection requirements.

## **Massachusetts**

Contact: Jim Danila, Assistant State Traffic Engineer, Traffic and Safety Engineering Section, Highway Division, Massachusetts Department of Transportation, 857-368-9640, [James.Danila@state.ma.us](mailto:James.Danila@state.ma.us).

1. **Documentation:** Our guidance is currently in draft form, so it has not been posted to our website.
2. **Allowances behind temporary barrier:** No. For protection from a drop-off, available slide room must meet or exceed crash-tested dynamic deflection values. No allowances are provided.
3. **Surface under temporary barrier:** The surface within the slide room area must have similar or better surface friction properties and cannot contain loose or uneven materials that may cause uneven redistribution of energy or unexpected rotation of barrier segments.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: For all conditions, the designer of record is responsible for identifying the available slide room to a drop-off or fixed object and the contractor is responsible for providing a barrier system that meets those specifications.
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: [No response.]
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: Anchors are selected by contractor per condition barrier is deployed. MassDOT allows virtually any barrier system that has been tested to MASH.
5. **Overlap:** Depending on site conditions, MassDOT allows either method. If overlapping barriers are used, a minimum of 60' of overlap is required.
6. **Head-to-head protection:** Assuming "head-to-head" means separation of two way traffic, yes. MassDOT requires the space between the barrier face and the yellow edge line meet or exceed the tested permanent deflection value.
7. **Criteria for temporary barrier use:** The barrier is required to protect from a drop-off under all conditions. For fixed objects, an evaluation is made regarding whether the TTC setup increases the exposure of the fixed object and, if so, if it is most effective to remove it, protect it with attenuation, make it crashworthy, or protect it with barrier.
8. **Installation near curb:** Under high speed conditions the curb is most often considered an object that will impede deflection; a barrier with less deflection or placement of the barrier behind the curb is required. Low-speed conditions are examined on a case-by-case basis depending for geometric constraints, probability of impact, etc.
9. **Clear zone distance in work zones:** No.
10. **Alternatives to anchoring PCBs:** The TxDOT X-bolt barrier is the only system we are aware of that does requires no anchoring and minimizes deflection. The NY State DOT barrier that has a box beam stiffener on the non-traffic side is pinned only at the ends of the run and has a relatively low deflection value.

## **Michigan**

Contact: Chris Brookes, Work Zone Delivery Engineer, Work Zone Safety and Mobility, Michigan Department of Transportation, 517-636-0300, [BrookesC@michigan.gov](mailto:BrookesC@michigan.gov).

### **1. Documentation:**

- a. Road Design Manual <http://mdotcf.state.mi.us/public/design/englishroadmanual/>
- b. Work Zone Safety and Mobility Manual (under revision current version)  
[http://www.michigan.gov/documents/mdot/MDOT\\_WorkZoneSafetyAndMobilityManual\\_233891\\_7.pdf](http://www.michigan.gov/documents/mdot/MDOT_WorkZoneSafetyAndMobilityManual_233891_7.pdf)

### **2. Allowances behind temporary barrier:** Yes. See:

- a. <http://mdotcf.state.mi.us/public/design/englishstandardplans/spdetails/index.htm> (R-53 detail).
- b. See this page for Special Provisions for the above detail:  
<http://mdotjboss.state.mi.us/SpecProv/specProvHome.htm>. See TCB limited deflection under 812 - 4 different SP's.

### **3. Surface under temporary barrier:**

For normal TCB [temporary concrete barrier], yes, we would allow the placement of temporary barrier on a compacted gravel or aggregate, as long as it is outside the distance specified for deflection for that barrier wall.

When using a limited deflection temporary barrier (required when the barrier is placed less than 26" from a precipitous drop-off), an appropriate detail from MDOT Special Detail R-53-Series must be utilized based on the proposed barrier offset from the drop-off and the underlying surface type. Most details identified in MDOT Special Detail R-53-Series are limited to specific pavement types. However, Detail 1 (box-beam stiffened method) from MDOT Special Detail R-53-Series may be used on all pavement types (e.g., concrete, HMA [hot-mix asphalt], composite). The decision to use Detail 1 from MDOT Special Detail R-53-Series on a compacted aggregate base would have to be evaluated by MDOT on a case-by-case basis, since it would depend on the ability to anchor the ends of the limited deflection barrier to the underlying surface or extend the barrier a sufficiently long distance beyond the area requiring limited deflection barrier. Again, this would have to be evaluated on a case-by-case basis by MDOT, since MDOT does not have specific guidelines addressing the use [of] limited deflection temporary barriers on compacted aggregate or dirt roadways.

### **4. Deflection space behind temporary barrier:**

- a. Unanchored/no protection: [No response.]
- b. Anchored/protection: [No response.]
- c. Unanchored/severe drop-off: [No response.]
- d. Anchored/severe drop-off: [No response.]
- e. Explanation of temporary barriers/anchors used: See  
<http://mdotcf.state.mi.us/public/design/englishstandardplans/spdetails/index.htm>

### **5. Overlap:** Yes if it [is] done in a way that protects the endings. We ask for at least one full section of barrier wall to overlap. However, the decision to attach or overlap the temporary barrier is evaluated by MDOT on a case-by-case [basis], and the decision may vary by location depending on site-specific circumstances.

### **6. Head-to-head protection:** On all freeways that are on the same roadbed.

7. **Criteria for temporary barrier use:** MDOT Usage Criteria - Temporary longitudinal barrier shall be used: On all freeway projects where opposing traffic lanes are adjacent to each other or when dividing bi-directional traffic on roadways where the posted speed limit prior to construction is 50 mph or higher. Temporary longitudinal barriers are not required on projects where motorists and non-motorized traffic lanes are adjacent to each other when a non-mountable curb is in place. Work Zone Safety Mobility Manual Page 17-1 thru 17-2:  
([http://www.michigan.gov/documents/mdot/MDOT\\_WorkZoneSafetyAndMobilityManual\\_233891\\_7.pdf](http://www.michigan.gov/documents/mdot/MDOT_WorkZoneSafetyAndMobilityManual_233891_7.pdf)). This will be changing in the near future.
8. **Installation near curb:** This would have to be evaluated on a case-by-case basis by MDOT, since MDOT does not have specific guidelines addressing this topic. Items that MDOT would take into consideration include: curb type, prevailing speeds, duration of barrier wall placement, traffic volumes, location (e.g., urban/rural, etc.), length of curb being impacted, extent of work required to replace the curb, other work items that would be required in order to replace the curb, etc. Obviously, the decision will vary by location and will be site-specific.
9. **Clear zone distance in work zones:** No.
10. **Alternatives to anchoring PCBs:** Box beam stiffeners as detailed in R-53.

### **Minnesota**

Contact: Jeffrey Morey, Work Zone Specialist, Office of Traffic, Safety and Technology, Minnesota Department of Transportation, 651-234-7058, [Jeffrey.Morey@state.mn.us](mailto:Jeffrey.Morey@state.mn.us).

1. **Documentation:** N/A.
2. **Allowances behind temporary barrier:** Yes. MnDOT does not have a formal policy, but a common practice allows up to a 4 foot subcut to occur within two feet of the back of the Portable Concrete Barrier if the length of the subcut is limited to 100 feet and the subcut is backfilled at the end of the work shift.
3. **Surface under temporary barrier:** Yes. MnDOT does not have a formal policy, but practice allows installation of Portable Concrete Barrier on pavement with the deflection area allowed on to a compacted aggregate base.
4. **Deflection space behind temporary barrier:** MnDOT practice is indicated in Bridge Memo to Designers. This memo was developed exclusively for bridge decks; however, this has been adopted for other applications. As stated previously, MnDOT uses a portable concrete barrier.
5. **Overlap:** Current MnDOT practice is to try for a minimum of 50' overlap with a 12" spacing between Barrier runs.
6. **Head-to-head protection:** MnDOT will generally not use a portable concrete barrier for single lane traffic in each direction. It will instead separate using tube delineators, temporary raised pavement markers, and striping. However, there are specific freeways in the Twin Cities Metropolitan area for which a portable concrete barrier is used for single lane traffic in each direction. A portable concrete barrier will also be used when separating multiple lanes in each direction. When a portable concrete barrier is used, 2 feet is the desired inside shoulder for each direction and it is generally not anchored.
7. **Criteria for temporary barrier use:** MnDOT will typically use a portable concrete barrier in long term projects (duration greater than 3 days) that have large drop offs or hazards, and to protect workers.
8. **Installation near curb:** MnDOT tries to avoid installing a portable concrete barrier near the curb; however, if engineering judgment deems the portable concrete barrier necessary near the curb, it is installed either all on top of the curb or butted up to the curb. This would only be for a portable concrete barrier as the other temporary barrier types generally require anchoring.

9. **Clear zone distance in work zones:** MnDOT generally uses a 30' clear zone for speeds greater than 55 mph in construction zones, whether in tangent or horizontal curvature. Otherwise, Table 9-1 of the AASHTO Roadside Design Guide is used as a resource.
10. **Alternatives to anchoring portable concrete barriers:** MnDOT has not tried the two runs of barrier, but would be interested if other states have done so.

### **Montana**

Contact: Jim Wingerter, Construction Traffic Control Engineer, Construction Engineering Services Bureau, Montana Department of Transportation, 406-454-5897, [JWingerter@mt.gov](mailto:JWingerter@mt.gov).

1. **Documentation:** Yes. Link is not active at this time. However, the link should be active soon.
2. **Allowances behind temporary barrier:** No.
3. **Surface under temporary barrier:** TCB allowed on non-paved surfaces if barriers properly pinned together.
4. **Deflection space behind temporary barrier:** [No response.]
  - a. Unanchored/no protection: [No response.]
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: [No response.]
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: [No response.]
5. **Overlap:** No, must be attached.
6. **Head-to-head protection:** No, Montana Department of Transportation does not use TCB for head to head traffic.
7. **Criteria for temporary barrier use:** Drop-off specification.
8. **Installation near curb:** No.
9. **Clear zone distance in work zones:** Yes. Dependent of speed and ADT.
10. **Alternatives to anchoring PCBs:** None.

### **Nebraska**

Contact: Matt Neemann, Traffic Control Engineer, Traffic Engineering Division, Nebraska Department of Roads, 402-479-4594, [Matt.Neemann@nebraska.gov](mailto:Matt.Neemann@nebraska.gov).

1. **Documentation:** No.
2. **Allowances behind temporary barrier:** No.
3. **Surface under temporary barrier:** No, but in these cases, it typically is pavement.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 2'.
  - b. Anchored/protection: 1'.
  - c. Unanchored/severe drop-off: 2'.
  - d. Anchored/severe drop-off: 1'.
  - e. Explanation of temporary barriers/anchors used: We pin them.
5. **Overlap:** We have in the past—at least 2 barriers past the end.

6. **Head-to-head protection:** We only use barriers for head to head when there are 2 lanes or more in each direction.
7. **Criteria for temporary barrier use:** Work duration and type of work are the main criteria we use.
8. **Installation near curb:** The barrier is typically placed on top of the curb (or behind the curb) if possible.
9. **Clear zone distance in work zones:** Yes. We use the guidance from the Roadside Design Guide.
10. **Alternatives to anchoring PCBs:** We typically provide enough space behind the barriers to avoid anchoring them into new pavements or bridge decks.

### **New Hampshire**

Contact: Ted Kitsis, Administrator, Construction, New Hampshire Department of Transportation, 603-271-2571, [Ted.Kitsis@dot.nh.gov](mailto:Ted.Kitsis@dot.nh.gov).

1. **Documentation:**  
[http://www.nh.gov/dot/org/projectdevelopment/highwaydesign/documents/FINAL\\_positive\\_protection\\_workzone\\_guidance\\_02221.pdf](http://www.nh.gov/dot/org/projectdevelopment/highwaydesign/documents/FINAL_positive_protection_workzone_guidance_02221.pdf).
2. **Allowances behind temporary barrier:** Yes. Anything less than a 2' deflection will require a restrained PCB system to minimize deflection.
3. **Surface under temporary barrier:** No we have placed PCB on a gravel surface and have not found it to act much differently than on pavement. We don't anchor our PCBs, rather we pin them with 1-1/4" steel rods.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 2'.
  - b. Anchored/protection: No offset.
  - c. Unanchored/severe drop-off: 2'.
  - d. Anchored/severe drop-off: No offset.
  - e. Explanation of temporary barriers/anchors used: We don't anchor our PCBs. Rather we place a restraining steel section behind the PCB to limit the allowable deflection.
5. **Overlap:** Yes to overlapping other PCB barrier and only in short term situation to GR. Usually only one or two lengths of barrier are overlapped depending on the allowable room.
6. **Head-to-head protection:** We follow the guidance of the Roadside Design Guide and the MUTCD for all temporary protection.
7. **Criteria for temporary barrier use:** The criteria [are] contained in our Positive Protection Guidance for Work Zones. Link provided in question [No. 1].
8. **Installation near curb:** We don't always consider the presence of curb when designing temporary barrier. On many occasions I have seen the PCB placed up and over the curbing, creating sharp and difficult connection points between PCB sections.
9. **Clear zone distance in work zones:** No.
10. **Alternatives to anchoring PCBs:** We have a PCB braced barrier detail that we have been using for some time. We used to anchor the PCB on our decks but had to come up with an alternative as we didn't want to core into new decks. (See [Appendix A](#).)

### **North Dakota**

Contact: Doug Schumaker, Traffic Safety Engineer, North Dakota Department of Transportation, 701-328-1210, [DSchumak@nd.gov](mailto:DSchumak@nd.gov).

1. **Documentation:** No manual.
2. **Allowances behind temporary barrier:** No.
3. **Surface under temporary barrier:** Pavement is not required. NDDOT provides the 2' as a minimum.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 2'.
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: 2'.
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: NDDOT does not anchor barriers down. We adopted the Georgia DOT barrier.
5. **Overlap:** Will overlap in front of barriers or guardrail. No formal policy on length.
6. **Head-to-head protection:** No formal policy. On a project by project basis if requested by Highway Patrol, NDDOT District or some other entity. [Then] it will be considered and discussed.
7. **Criteria for temporary barrier use:** Typically no barrier is less than two weeks. It also depends on the obstruction or dropoff. If no escape route for workers [then] barrier is used such as on a bridge.
8. **Installation near curb:** Barrier is set in front if 2' is not provided.
9. **Clear zone distance in work zones:** No.
10. **Alternatives to anchoring PCBs:** No alternatives used. Take other actions to provide for the 2' requirements such as close lane or detour.

### **Ohio**

Contact: Dan Groh, Construction Traffic & Roadway Engineering, Construction Administration, Ohio Department of Transportation, 614-387-1162, [Dan.Groh@dot.ohio.gov](mailto:Dan.Groh@dot.ohio.gov).

- **Documentation:** See our Transportation Engineering Manual Section 605-14 and the links to the various standard construction drawings contained in this section. The links are also copied below.
  - a. [http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/TEM/Documents/Part\\_06\\_Complete\\_012017Revision\\_bookmarked.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/TEM/Documents/Part_06_Complete_012017Revision_bookmarked.pdf)
  - b. MT-95.70:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09570\\_2013-07-19.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09570_2013-07-19.pdf)
  - c. MT-95.71:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09571\\_2013-07-19.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09571_2013-07-19.pdf)
  - d. MT-95.72:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09572\\_2017-01-20\\_.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09572_2017-01-20_.pdf)



- e. MT-95.73:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09573\\_2017-01-20.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09573_2017-01-20.pdf)
- f. MT-101.90:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_10190\\_2015-07-17.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_10190_2015-07-17.pdf)
- g. Portable Concrete Barrier Installation Guidelines drawing:  
<http://www.dot.state.oh.us/Divisions/Engineering/Structures/standard/Bridges/test/pcbdd.pdf>
- h. Location and Design Manual Volume 1 Section 600:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section\\_600\\_Jan\\_2017.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section_600_Jan_2017.pdf)
- i. Roadway Standard Construction Drawings:  
<http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Pages/StandardConstructionDrawing.aspx>
- j. Link to MT-101.80:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_10180\\_2015-01-16.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_10180_2015-01-16.pdf)
- **Allowances behind temporary barrier:** No. We do not specify any deflection space requirements at this time. We do not have any time or length sensitive allowances. However, designers are provided with guidance on our FAQ page  
[\[https://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Pages/FAQandDesignerInformation.aspx\]](https://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Pages/FAQandDesignerInformation.aspx). See the excerpt below:  
  
**Portable Concrete Barrier - Lateral Deflection.**  
 Historically, ODOT has used 2 feet as the deflection of unanchored PCB. This dimension more realistically represents the desirable minimum offset distance from a traveled lane to the PCB. With regards to probable deflections, most crash tested portable concrete barriers (nominal 60 mph, 25 degree with a 3/4 ton pickup truck) were displaced laterally up to between 5 to 6 feet. ODOT's own 32" design deflected 5.5 feet, but this 2001 crash test was conducted on a 244 feet long run unanchored at each end (Similarly, ODOT's generic 50" design deflected 6.2 feet in the 2006 compliance crash testing). It may be assumed that a longer run would have less deflection as more friction and tension would be available, and that impact angles in tight work zone locations are not as severe the 25 degree impact of the standard 3-11 test. In 2003 the Midwest Roadside Safety Facility concluded in its "Deflection Limits for Temporary Concrete Barriers" report that the 85 percentile accident in a normal work zone installation would produce a 2 foot deflection in an Iowa barrier. It is assumed the differences between the Iowa and Ohio barriers would not be significant with respect to this report. The report also says to use the full deflection if used in freestanding mode adjacent to the edge of a bridge deck or similar drop off - but ODOT designers should use Structural Engineering's Design Data Sheet PCBDD to calculate Bridge Mounted Barrier anchorage in these situations. Two feet continues to be an appropriate deflection limit criterion between two sets of travel lanes. It is also a valid distance between PCB protecting the traveled lanes and construction equipment or personnel. But keep in mind that larger deflections are entirely possible. The full deflection offset is desirable if the barrier is protecting motorists from fixed objects.
- **Surface under temporary barrier:** We do not have any specific specifications in regards to this. The following excerpt is from our Construction and Material Specifications. "622.01 This work consists of furnishing and placing [p]ortland cement concrete barrier on the accepted and prepared subgrade, subbase course, or existing pavement."



- **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: Our standards don't currently speak to this space so therefore none required (see guidance above).
  - b. Anchored/protection: Our standards don't currently speak to this space so therefore none required (see guidance above).
  - c. Unanchored/severe drop-off: See Figure 2 in the Portable Concrete Barrier Installation Guidelines drawing.
  - d. Anchored/severe drop-off: See Portable Concrete Barrier Installation Guidelines drawing.
  - e. Explanation of temporary barriers/anchors used: From our Portable Concrete Barrier Installation Guidelines Note 3.
- **Overlap:** Per our Transportation Engineering Manual [page 6-49 of the manual, page 49 of the PDF]:

#### 605-14.5.2 End Treatment

The exposed end of the PB [portable barrier] should be located at a distance from the edge of the traveled way equal to the clear zone distance for the facility as discussed in L&D Manual Volume 1, Section 600.2. When this is not practical, impact attenuators shall be provided on the exposed ends of PB located within the clear zone.

Except as noted, exposed ends of PB located outside the clear zone shall be tapered. The leading end of PB does not need be tapered if shielded by another run of overlapping PB, permanent concrete barrier, or fully anchored guardrail (with anchor assembly). However, the PB should extend/overlap at least 50 feet with a guardrail end. Connections or field transitions to guardrail are not crashworthy and are not permitted. Abutting or connecting PB to permanent concrete barrier or parapets is non-standard and requires special anchoring and design details. See Traffic SCD MT-101.80 for design guidance for transitioning portable concrete barrier (does not pertain to portable steel barriers) to permanent concrete barrier.

For acceptable flare rates for PB, see L&D Manual Volume 1, Figure 602-1 and the SCDs [Standard Construction Drawings]. See Section 620-2 for information on the NCHRP 350 requirements.

- **Head-to-head protection:** Per our Transportation Engineering Manual Section 605-14.1 [page 6-47 of the manual, page 47 of the PDF]:

At a minimum, temporary traffic barriers shall be considered in work zone situations that place workers at increased risk from motorized traffic, and where these barriers offer the highest potential for increased safety for workers and road users, such as:

1. The work zone provides no means of escape for workers (e.g., tunnels and bridges). Adjacent lanes, carrying traffic flowing in opposite directions on Interstates, freeways, and other high-speed (>45 miles per hour) multi-lane divided highways (see Traffic SCDs MT-95.70, MT-95.71, MT-95.72, and MT-95.73).

Portable barrier is the only separation option shown in the Standard Construction Drawings MT-95.70, MT-95.71, MT-95.72, and MT-95.73.

MT-95.70

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09570\\_2013-07-19.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09570_2013-07-19.pdf)

MT-95.71

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09571\\_2013-07-19.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09571_2013-07-19.pdf)

MT-95.72

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09572\\_2017-01-20\\_.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09572_2017-01-20_.pdf)

MT-95.73

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09573\\_2017-01-20.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09573_2017-01-20.pdf)

- **Criteria for temporary barrier use:** 605-14 Temporary Traffic Barriers [page 6-47 of the manual, page 47 of the PDF]:

#### 605-14.1 General

Temporary traffic barriers are devices designed to help prevent penetration by vehicles while minimizing injuries to vehicle occupants, and designed to protect workers, bicyclists and pedestrians (see OMUTCD Section 6F.85). More specific information on the use of temporary traffic barriers is contained in AASHTO's Roadside Design Guide.

Because the protective requirements of a temporary traffic control situation have priority in determining the need for temporary traffic barriers, their use shall be based on an engineering study.

At a minimum, temporary traffic barriers shall be considered in work zone situations that place workers at increased risk from motorized traffic, and where these barriers offer the highest potential for increased safety for workers and road users, such as:

1. The work zone provides no means of escape for workers (e.g., tunnels and bridges). Adjacent lanes, carrying traffic flowing in opposite directions on Interstates, freeways, and other high-speed (>45 miles per hour) multi-lane divided highways (see Traffic SCDs MT-95.70, MT-95.71, MT-95.72, and MT-95.73).
2. Long-term work zones (e.g., two weeks or more).
3. Workers close to travel lanes open to traffic.
4. Drop-off areas (see Traffic SCD MT-101.90).
5. Projects with high operating speeds and high traffic volumes.
6. Bridge decks where the parapet or guardrail is removed (see SCD PCB-91 and the Design Data Sheet PCBDD on the Office of Structural Engineering Publications web page).

Warning lights or steady-burn electric lamps may also be mounted on temporary traffic barrier installations. When serving the additional function of channelizing vehicular traffic, temporary traffic barriers should be a light color for increased visibility.

#### 605-14.2 Length of Need

The method used to design the length of need and location of barrier for maintenance of traffic applications should be as discussed in L&D Manual Volume 1, Sections 602.1.2 and 602.1.3 for determining barrier length.

Length of need typically does not include attenuators, thus work zone design must take this into account.

There is also the Standard Construction Drawing for Impact Attenuator Placement (MT-101.75) that discusses length of need.

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_10175\\_2016-07-15.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_10175_2016-07-15.pdf)

- **Installation near curb:**

We do not have any specifications for these situations. For the placement of impact attenuators see the excerpt below:

From the Location and Design Manual Volume 1 [page 6-10 of the manual, page 14 of the PDF]:

#### 602.1.5.3 End Treatments and Impact Attenuators in Curbed Sections

None of the approved anchor assemblies or impact attenuators listed in Sections 603.3 and 603.4 have been designed or tested for use with curbs; consequently, the designer should use the guidelines provided for uncurbed sections in addition to engineering judgment and recommendations from the manufacturer to select end treatments in curbed sections. The current recommendation from product vendors is to ensure curbs are not present (if practical) along the length of the product and for a distance of 50 feet in advance of the product. When terminating or removing curbs in the vicinity of end treatments and impact attenuators remember to taper the curb height from 4 or 6 inches to flush with the pavement over a distance of 10 feet.

- **Clear zone distance in work zones:** Yes. Table 600-1E in the Location and Design Manual Volume 1 Section 600 is the table for permanent clear zone widths, and it takes into account speed, volume, foreslope, backslope, and horizontal curve correction factors. The work zone standard construction drawings that discuss clear zone include a much more simplified table that is only based on speed. The links to the publications are below. [Figure] 600-1E in the Location and Design Manual (page 36 of the PDF):

Volume 1 Section 600

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section\\_600\\_Jan\\_2017.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section_600_Jan_2017.pdf)

- **Alternatives to anchoring PCBs:** We don't have any specific methods for avoiding anchoring.

### **South Carolina**

Contact: Joe Sease, South Carolina Department of Transportation, 803-737-1460, [SeaseJC@scdot.org](mailto:SeaseJC@scdot.org).

1. **Documentation:** We have standard drawings regarding design and utilization of temporary concrete barrier walls.
2. **Allowances behind temporary barrier:** Yes. We only require anchorage on bridge decks where there is 8 feet or less of space between the edge of the unprotected bridge deck and the near edge of the barrier wall.
3. **Surface under temporary barrier:** Please see the [answer] for [No. 2]. Anchorage must be into a concrete pavement or bridge deck.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 3 feet.
  - b. Anchored/protection: 1 foot is preferred.
  - c. Unanchored/severe drop-off: 8 feet.
  - d. Anchored/severe drop-off: 5 feet.
  - e. Explanation of temporary barriers/anchors used: Adhesive is only option at this time.
5. **Overlap:** Barrier overlapping barrier must be at least 1 section. Barrier overlapping guardrail must be attached in accordance with standard drawings.
6. **Head-to-head protection:** At all times when opposing directions of travel normally separated by an earth median are temporarily located in a "head to head" configuration.
7. **Criteria for temporary barrier use:** Proximity and severity of drop-offs and at all times when travel lanes normally separated by an earth median are temporarily located in a "head to head" configuration.
8. **Installation near curb:** We have no specific requirements.
9. **Clear zone distance in work zones:** Yes. The end must be protected by an attenuator unless the approach section is tapered away at a rate of 10:1 to a point that locates the end 30 feet from the near edge of the approaching travel lane or the approach section is tapered away at a rate of 8:1 to a point that locates the end 15 feet from the near edge of the opposing travel lane for speeds of 40 and less.
10. **Alternatives to anchoring PCBs:** We do not anchor walls on new pavements.

### **Utah**

Contact: Josh Van Jura, Project Controls and Claims Engineer, Engineering Section, Utah Department of Transportation, 801-231-8452, [JVanJura@utah.gov](mailto:JVanJura@utah.gov).

1. **Documentation:** TC-3B of the standard drawings -  
<https://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:4867>  
[<http://www.udot.utah.gov/main/uconowner.gf?n=31730514811123516>, page 403 of the PDF]
2. **Allowances behind temporary barrier:** No.

3. **Surface under temporary barrier:** Must be pavement.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 1' hard surface and 2' at 8:1 or flatter.
  - b. Anchored/protection: 1'.
  - c. Unanchored/severe drop-off: 1' hard surface and 2' at 8:1 or flatter.
  - d. Anchored/severe drop-off: 1'.
  - e. Explanation of temporary barriers/anchors used: Precast concrete w/pins.
5. **Overlap:** Yes, distance not defined.
6. **Head-to-head protection:** Any inte[r]state or high steep requires barrier. Standard Drawing [TC] 7, see link above [page 414 of the PDF].
7. **Criteria for temporary barrier use:** Standard Barrier TC-3B. UDOT Policy 08-05.
8. **Installation near curb:** Along the face of the curb.
9. **Clear zone distance in work zones:** Yes. Dependent on speed. Standard Drawing TC-3B.
10. **Alternatives to anchoring PCBs:** Require deflection difference. Sadly we have the same problem. We view as construction phasing problems.

### **Vermont**

Contact: Nancy Avery, Vermont Agency of Transportation, 802-279-5991, [Nancy.Avery@vermont.gov](mailto:Nancy.Avery@vermont.gov).

1. **Documentation:** VTrans uses the attached standards and the Roadside Design Guide for information. We do not have an Agency manual addressing this issue specifically.
  - a. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt35.pdf>
  - b. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt36.pdf>
2. **Allowances behind temporary barrier:** No. We follow recommendations established in the Roadside Design Guide.
3. **Surface under temporary barrier:** We follow recommendations established in the Roadside Design Guide.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: [No response.]
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: [No response.]
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: See State Standard Drawing T-35&T-36.
5. **Overlap:** We do not overlap barrier unless it is guard rail overlapping/attached to temporary concrete barrier.
6. **Head-to-head protection:** Not sure. This terminology is unfamiliar to me.
7. **Criteria for temporary barrier use:**
  - a. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt11.pdf>
  - b. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt12.pdf>

- c. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt13.pdf>
  - d. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt14.pdf>
  - e. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt15.pdf>
8. **Installation near curb:** We follow, if any, recommendations established in the Roadside Design Guide.
  9. **Clear zone distance in work zones:** We follow recommendations established in the Roadside Design Guide Chapter 9.
  10. **Alternatives to anchoring PCBs:** None that I know of.

### **Virginia**

Contact: Charles Collins, Virginia Department of Transportation, 804-690-4574,  
[Charles.Collins@vdot.virginia.gov](mailto:Charles.Collins@vdot.virginia.gov).

1. **Documentation:** Yes. Va. [W]ork Area Protection manual (VAWAPM) and pocket guide. We also use the MUTCD Book: <http://www.virginiadot.org/business/trafficeng-WZS.asp>
2. **Allowances behind temporary barrier:** Yes. Yes in the VAWAPM. Formula takes into account traffic count/incident values and time.
3. **Surface under temporary barrier:** If we don't have adequate surface to anchor to, contractors are required to pour concrete or place asphalt pads.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: The deflection distance is generated by the [manufacturer's] deflection distance noted in their data sheets. 100% derived per manufacturer and lengths of barriers.
  - b. Anchored/protection: o deflection.
  - c. Unanchored/severe drop-off: If the drop off is in the Deflection zone of the barrier that is in place this scenario is 100% disallowed. Distance must be greater than the deflection area which greatly varies between types of barriers.
  - d. Anchored/severe drop-off: This TOTALLY depends on the type of barrier bolting [system. In] our state we require that bolting on bridges must use barriers with all anchoring done from the front of the barrier leaving over 12 inches of concrete to help maintain pull out strength and our systems bolt completely [throughout] the deck unless approved by the engineer. If you folks have barriers that bolt front and back you would need 12 inches of concrete behind the barrier for strength of deck (Bolt may pull out if concrete fails).
  - e. Explanation of temporary barriers/anchors used: We use several manufacturers for our barrier but our anchoring system is a bolt thru on decks unless it is a 2 phase deck then we use epoxy systems or [H]ilti systems and test the pull out strength of the connection. We pin barriers when we are on roadway surfaces (Grade). We utilize 1 inch pins with 24 inch embedment.
5. **Overlap:** Yes we do overlap. That detail is in the VAWAPM which addresses numerous configurations.
6. **Head-to-head protection:** Yes we do use it. Determined by values in [A]ppendix [A] of VAWAPM.
7. **Criteria for temporary barrier use:** That is determined in the time/need formula in [A]ppendix A of the VAWAPM.
8. **Installation near curb:** This is such a broad thought it is hard to answer. Examples if there is room we put it in front of the curb: I[f] there isn't enough lane we may remove the curb set barrier and repour

curb when barrier is removed: We also set barrier on utility strip above curb. This is totally developed per job basis.

9. **Clear zone distance in work zones:** No. Clear Zone distances are noted on page A4 in Appendix A of the VAWAPM.
10. **Alternatives to anchoring PCBs:** Please review VAWAPM. [I]t details how to do this with sand bags between two individual runs. VDOT's Road and Bridge standards book Volume I page 502.04. Please call if you have any questions.

### **Washington**

Contact: Steve Haapala, State Work Zone Engineer, Traffic Operations, Washington State Department of Transportation, 360-705-7241, [HaapalS@wsdot.wa.gov](mailto:HaapalS@wsdot.wa.gov).

1. **Documentation:**
  - a. <http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/1610.pdf>
  - b. <http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/1010.pdf>
  - c. <http://www.wsdot.wa.gov/Design/Standards/#SectionK>
2. **Allowances behind temporary barrier:** No.
3. **Surface under temporary barrier:** We also require anchoring if there is minimal deflection area or on a bridge as temporary bridge rail. We may have used temporary barrier on compacted gravel in low speed applications for short distances for culvert replacements when traffic is diverted around the work area on a compacted gravel surface.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 2'.
  - b. Anchored/protection: See our Standard Plans.
  - c. Unanchored/severe drop-off: 3'.
  - d. Anchored/severe drop-off: See our Standard Plans.
  - e. Explanation of temporary barriers/anchors used: See our Standard Plans.
5. **Overlap:** This is done at times. Usually a few barrier sections if they are near the existing barrier. I do not think we have a standard. Length of need calculations should be done in other cases to protect blunt ends.
6. **Head-to-head protection:** Based on project specific needs. Same for Question [No. 5].
7. **Criteria for temporary barrier use:** See our Design Manual Chapter 1010.10.
8. **Installation near curb:** Not sure. Barriers are not often used on this type of highway.
9. **Clear zone distance in work zones:** Yes. See:  
[http://www.wsdot.wa.gov/publications/fulltext/projectdev/gspspdf/1-07.23\(1\).OPT2.GR1.PDF](http://www.wsdot.wa.gov/publications/fulltext/projectdev/gspspdf/1-07.23(1).OPT2.GR1.PDF)
10. **Alternatives to anchoring PCBs:** None that I am aware of other than trying to stage the work so anchoring is not required or not done on final roadway surface.

## **Wisconsin**

Contact: Erik Emerson, Standards Development Engineer, Roadside Design, Wisconsin Department of Transportation, 608-266-2842, [Erik.Emerson@wi.gov](mailto:Erik.Emerson@wi.gov).

1. **Documentation:** See 11-50-53 <http://wisconsindot.gov/rdwy/fdm/fd-11-50.pdf>
2. **Allowances behind temporary barrier:** No.
3. **Surface under temporary barrier:** Current standard requires paved surface.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 4' 45 mph or more, 2' less than 40.
  - b. Anchored/protection: no language as of yet.
  - c. Unanchored/severe drop-off: 4' 45 mph or more. 2' less than 40,
  - d. Anchored/severe drop-off: min. 6" back from edge.
  - e. Explanation of temporary barriers/anchors used: bolt through deck, adhesive anchors and ac pin.
5. **Overlap:** Overlap over other temporary barriers. Current overlap 8 barrier sections.
6. **Head-to-head protection:** Don't understand the term.
7. **Criteria for temporary barrier use:** See 11-50-53.
8. **Installation near curb:** We tell people to avoid placing near curb.
9. **Clear zone distance in work zones:** Yes. See 11-50-53.
10. **Alternatives to anchoring PCBs:** WisDOT is currently researching developing a crashworthy low deflection barrier system.

## **Wyoming**

Contact: Jeff Mellor, Wyoming Department of Transportation, 307-777-4164, [Jeffery.Mellor@wyo.gov](mailto:Jeffery.Mellor@wyo.gov).

1. **Documentation:** No.
2. **Allowances behind temporary barrier:** No.
3. **Surface under temporary barrier:** No, Yes, Unknown.
4. **Deflection space behind temporary barrier:**
  - a. Unanchored/no protection: 4.
  - b. Anchored/protection: 0.
  - c. Unanchored/severe drop-off: 4.
  - d. Anchored/severe drop-off: 2-4.
  - e. Explanation of temporary barriers/anchors used: See Kansas pinned portable details. [Note: Survey respondent did not provide this information.]
5. **Overlap:** Yes, 9 barrier sections.
6. **Head-to-head protection:** Part of standard plans interstate. No formal guidance.
7. **Criteria for temporary barrier use:** Protection of vertical drop offs.
8. **Installation near curb:** Try to avoid placing next to curb.
9. **Clear zone distance in work zones:** Yes. 15.
10. **Alternatives to anchoring PCBs:** [No response.]



## **Survey Responses by Question**

For MnDOT's convenience, the survey responses are repeated below, organized by question.

### **1. Documentation**

- **Arkansas:** [http://www.arkansashighways.com/roadway\\_design\\_division/usunits/usunit.aspx](http://www.arkansashighways.com/roadway_design_division/usunits/usunit.aspx)
- **California:** No, Caltrans does not have a manual for temporary barriers.
- **Delaware:**
  - a. Yes, we created a Design Guidance Memorandum in response to the Final Rule on Temporary Traffic Control Devices. [http://www.deldot.gov/information/pubs\\_forms/manuals/dgm/pdf/1-21\\_use\\_temp\\_traffic\\_barrier\\_wz.pdf](http://www.deldot.gov/information/pubs_forms/manuals/dgm/pdf/1-21_use_temp_traffic_barrier_wz.pdf)
  - b. Also, please see the Delaware MUTCD, specifically Part 6 and Section 6F.85. [www.mutcd.deldot.gov](http://www.mutcd.deldot.gov)
- **Florida:**
  - a. Plans Preparation Manual (PPM) Chapter 4.4 <http://www.fdot.gov/roadway/PPMManual/2017/Volume1/Chap04.pdf>
  - b. Design Standards, Index 412, 414, 415 and 600 <http://www.fdot.gov/roadway/DS/18/STDs.shtm>
  - c. Standard Specifications, Section 102-9 <http://www.fdot.gov/programmanagement/Implemented/SpecBooks/January2017/Files/117eBook.pdf>
- **Massachusetts:** Our guidance is currently in draft form, so it has not been posted to our website.
- **Michigan:**
  - a. Road Design Manual <http://mdotcf.state.mi.us/public/design/englishroadmanual/>
  - b. Work Zone Safety and Mobility Manual (under revision current version) [http://www.michigan.gov/documents/mdot/MDOT\\_WorkZoneSafetyAndMobilityManual\\_233891\\_7.pdf](http://www.michigan.gov/documents/mdot/MDOT_WorkZoneSafetyAndMobilityManual_233891_7.pdf)
- **Minnesota:** N/A.
- **Montana:** Yes. Link is not active at this time. However, the link should be active soon.
- **Nebraska:** No.
- **New Hampshire:** [http://www.nh.gov/dot/org/projectdevelopment/highwaydesign/documents/FINAL\\_positive\\_protection\\_workzone\\_guidance\\_02221.pdf](http://www.nh.gov/dot/org/projectdevelopment/highwaydesign/documents/FINAL_positive_protection_workzone_guidance_02221.pdf).
- **North Dakota:** No manual.
- **Ohio:** See our Transportation Engineering Manual Section 605-14 and the links to the various standard construction drawings contained in this section. The links are also copied below.
  - a. [http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/TEM/Documents/Part\\_06\\_Complete\\_012017Revision\\_bookmarked.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/TEM/Documents/Part_06_Complete_012017Revision_bookmarked.pdf)
  - b. MT-95.70: [http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09570\\_2013-07-19.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09570_2013-07-19.pdf)
  - c. MT-95.71: [http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09571\\_2013-07-19.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09571_2013-07-19.pdf)

- d. MT-95.72:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09572\\_2017-01-20\\_.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09572_2017-01-20_.pdf)
- e. MT-95.73:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09573\\_2017-01-20.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09573_2017-01-20.pdf)
- f. MT-101.90:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_10190\\_2015-07-17.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_10190_2015-07-17.pdf)
- g. Portable Concrete Barrier Installation Guidelines drawing:  
<http://www.dot.state.oh.us/Divisions/Engineering/Structures/standard/Bridges/test/pcbdd.pdf>
- h. Location and Design Manual Volume 1 Section 600:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section\\_600\\_Jan\\_2017.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section_600_Jan_2017.pdf)
- i. Roadway Standard Construction Drawings:  
<http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Pages/StandardConstructionDrawing.aspx>
- j. Link to MT-101.80:  
[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_10180\\_2015-01-16.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_10180_2015-01-16.pdf)
- **South Carolina:** We have standard drawings regarding design and utilization of temporary concrete barrier walls.
- **Utah:** TC-3B of the standard drawings - <https://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:4867> [<http://www.udot.utah.gov/main/uconowner.gf?n=31730514811123516>, page 403 of the PDF]
- **Vermont:** VTTrans uses the attached standards and the Roadside Design Guide for information. We do not have an Agency manual addressing this issue specifically.
  - a. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt35.pdf>
  - b. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt36.pdf>
- **Virginia:** Yes. Va. [W]ork Area Protection manual (VAWAPM) and pocket guide. We also use the MUTCD Book: <http://www.viriniadot.org/business/trafficeng-WZS.asp>
- **Washington:**
  - a. <http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/1610.pdf>
  - b. <http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/1010.pdf>
  - c. <http://www.wsdot.wa.gov/Design/Standards/#SectionK>
- **Wisconsin:** See 11-50-53 <http://wisconsin.dot.gov/rdwy/fdm/fd-11-50.pdf>
- **Wyoming:** No.

## 2. **Allowances behind temporary barrier**

- **Arkansas:** Yes. Refer to standard drawing TC-5 in the link provided [in the answer to question No. 1].
- **California:** No.
- **Delaware:** No.

- **Florida:** No.
- **Massachusetts:** No. For protection from a drop-off, available slide room must meet or exceed crash-tested dynamic deflection values. No allowances are provided.
- **Michigan:** Yes. See:
  - a. <http://mdotcf.state.mi.us/public/design/englishstandardplans/spdetails/index.htm> (R-53 detail).
  - b. See this page for Special Provisions for the above detail:  
<http://mdotjboss.state.mi.us/SpecProv/specProvHome.htm>. See TCB limited deflection under 812 - 4 different SP's.
- **Minnesota:** Yes. MnDOT does not have a formal policy, but a common practice allows up to a 4-foot subcut to occur within two feet of the back of the [p]ortable [c]oncrete [b]arrier if the length of the subcut is limited to 100 feet and the subcut is backfilled at the end of the work shift.
- **Montana:** No.
- **Nebraska:** No.
- **New Hampshire:** Yes. Anything less than a 2' deflection will require a restrained PCB system to minimize deflection.
- **North Dakota:** No.
- **Ohio:** No. We do not specify any deflection space requirements at this time. We do not have any time or length sensitive allowances. However, designers are provided with guidance on our FAQ page [<https://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Pages/FAQandDesignerInformation.aspx>]. See the excerpt below:

#### **Portable Concrete Barrier - Lateral Deflection.**

Historically, ODOT has used 2 feet as the deflection of unanchored PCB. This dimension more realistically represents the desirable minimum offset distance from a traveled lane to the PCB. With regards to probable deflections, most crash tested portable concrete barriers (nominal 60 mph, 25 degree with a 3/4 ton pickup truck) were displaced laterally up to between 5 to 6 feet. ODOT's own 32" design deflected 5.5 feet, but this 2001 crash test was conducted on a 244 feet long run unanchored at each end (Similarly, ODOT's generic 50" design deflected 6.2 feet in the 2006 compliance crash testing). It may be assumed that a longer run would have less deflection as more friction and tension would be available, and that impact angles in tight work zone locations are not as severe the 25 degree impact of the standard 3-11 test. In 2003 the Midwest Roadside Safety Facility concluded in its "Deflection Limits for Temporary Concrete Barriers" report that the 85 percentile accident in a normal work zone installation would produce a 2 foot deflection in an Iowa barrier. It is assumed the differences between the Iowa and Ohio barriers would not be significant with respect to this report. The report also says to use the full deflection if used in freestanding mode adjacent to the edge of a bridge deck or similar drop off - but ODOT designers should use Structural Engineering's Design Data Sheet PCBDD to calculate Bridge Mounted Barrier anchorage in these situations. Two feet continues to be an appropriate deflection limit criterion between two sets of travel lanes. It is also a valid distance between PCB protecting the traveled lanes and construction equipment or personnel. But keep in mind that larger deflections are entirely possible. The full deflection offset is desirable if the barrier is protecting motorists from fixed objects.

- **South Carolina:** Yes. We only require anchorage on bridge decks where there is 8 feet or less of space between the edge of the unprotected bridge deck and the near edge of the barrier wall.
- **Utah:** No.
- **Vermont:** No. We follow recommendations established in the Roadside Design Guide.

- **Virginia:** Yes. Yes in the VAWAPM. Formula takes into account traffic count/incident values and time.
- **Washington:** No.
- **Wisconsin:** No.
- **Wyoming:** No.

### 3. Surface under temporary barrier

- **Arkansas:** Would need to be pavement so that the anchor would be effective.
- **California:** K rail must be supported by at least 4 inches thick concrete, hot mix asphalt or existing asphalt concrete pavement.
- **Delaware:** We require that the barrier be placed on a paved surface as that is how the barrier has been tested. This is not reflected in our current Design Guidance but is a state of the practice. The Design Guidance will be updated soon.
- **Florida:** When pavement does not exist, FDOT requires a temporary 2 inch asphalt pad installed in accordance with Standard Spec 339.
- **Massachusetts:** The surface within the slide room area must have similar or better surface friction properties and cannot contain loose or uneven materials that may cause uneven redistribution of energy or unexpected rotation of barrier segments.
- **Michigan:**  
For normal TCB [temporary concrete barrier], yes, we would allow the placement of temporary barrier on a compacted gravel or aggregate, as long as it is outside the distance specified for deflection for that barrier wall.

When using a limited deflection temporary barrier (required when the barrier is placed less than 26" from a precipitous drop-off), an appropriate detail from MDOT Special Detail R-53-Series must be utilized based on the proposed barrier offset from the drop-off and the underlying surface type. Most details identified in MDOT Special Detail R-53-Series are limited to specific pavement types. However, Detail 1 (box-beam stiffened method) from MDOT Special Detail R-53-Series may be used on all pavement types (e.g., concrete, HMA [hot-mix asphalt], composite). The decision to use Detail 1 from MDOT Special Detail R-53-Series on a compacted aggregate base would have to be evaluated by MDOT on a case-by-case basis, since it would depend on the ability to anchor the ends of the limited deflection barrier to the underlying surface or extend the barrier a sufficiently long distance beyond the area requiring limited deflection barrier. Again, this would have to be evaluated on a case-by-case basis by MDOT, since MDOT does not have specific guidelines addressing the use [of] limited deflection temporary barriers on compacted aggregate or dirt roadways.

- **Minnesota:** Yes. MnDOT does not have a formal policy, but practice allows installation of Portable Concrete Barrier on pavement with the deflection area allowed on to a compacted aggregate base.
- **Montana:** TCB allowed on non-paved surfaces if barriers properly pinned together.
- **Nebraska:** No, but in these cases, it typically is pavement.
- **New Hampshire:** No we have placed PCB on a gravel surface and have not found it to act much differently than on pavement. We don't anchor our PCBs, rather we pin them with 1-1/4" steel rods.
- **North Dakota:** Pavement is not required. NDDOT provides the 2' as a minimum.
- **Ohio:** We do not have any specific specifications in regards to this. The following excerpt is from our Construction and Material Specifications. "622.01 This work consists of furnishing and placing [p]ortland cement concrete barrier on the accepted and prepared subgrade, subbase course, or existing pavement."

- **South Carolina:** Please see the [answer] for [No. 2]. Anchorage must be into a concrete pavement or bridge deck.
- **Utah:** Must be pavement.
- **Vermont:** We follow recommendations established in the Roadside Design Guide.
- **Virginia:** If we don't have adequate surface to anchor to, contractors are required to pour concrete or place asphalt pads.
- **Washington:** We also require anchoring if there is minimal deflection area or on a bridge as temporary bridge rail. We may have used temporary barrier on compacted gravel in low speed applications for short distances for culvert replacements when traffic is diverted around the work area on a compacted gravel surface.
- **Wisconsin:** Current standard requires paved surface.
- **Wyoming:** No, Yes, Unknown.

#### 4. Deflection space behind temporary barrier

- **Arkansas:**
  - a. Unanchored/no protection: [No response.]
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: [No response.]
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: Refer to standard drawing.
- **California:**
  - a. Unanchored/no protection: 4 feet.
  - b. Anchored/protection: 2 feet.
  - c. Unanchored/severe drop-off: 4 feet.
  - d. Anchored/severe drop-off: 2 feet.
  - e. Explanation of temporary barriers/anchors used: K-Rail—24 inches capped stake.
- **Delaware:**
  - a. Unanchored/no protection: 4 feet.
  - b. Anchored/protection: 0 feet.
  - c. Unanchored/severe drop-off: Unspecified (evaluated on a case-by-case basis).
  - d. Anchored/severe drop-off: 0 feet (can be more on a case-by-case basis).
  - e. Explanation of temporary barriers/anchors used: We require NCHRP-350/MASH tested systems that utilize pins in either asphalt or concrete.
- **Florida:**
  - a. Unanchored/no protection: 2 feet minimum.
  - b. Anchored/protection: 1 foot minimum.
  - c. Unanchored/severe drop-off: 4 feet minimum.
  - d. Anchored/severe drop-off: 1 foot minimum (even less if bolted on bridges).
  - e. Explanation of temporary barriers/anchors used: 32" F Shape 12.5 feet long with 3/4" asphalt stakes or bridge deck bolts.

- **Massachusetts:**
  - a. Unanchored/no protection: For all conditions, the designer of record is responsible for identifying the available slide room to a drop-off or fixed object and the contractor is responsible for providing a barrier system that meets those specifications.
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: [No response.]
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: Anchors are selected by contractor per condition barrier is deployed. MassDOT allows virtually any barrier system that has been tested to MASH.
- **Michigan:**
  - a. Unanchored/no protection: [No response.]
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: [No response.]
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: See <http://mdotcf.state.mi.us/public/design/englishstandardplans/spdetails/index.htm>
- **Minnesota:** MnDOT practice is indicated in Bridge Memo to Designers. This memo was developed exclusively for bridge decks; however, this has been adopted for other applications. As stated previously, MnDOT uses a portable concrete barrier.
- **Montana:**
  - a. Unanchored/no protection: [No response.]
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: [No response.]
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: [No response.]
- **Nebraska:**
  - a. Unanchored/no protection: 2'.
  - b. Anchored/protection: 1'.
  - c. Unanchored/severe drop-off: 2'.
  - d. Anchored/severe drop-off: 1'.
  - e. Explanation of temporary barriers/anchors used: We pin them.
- **New Hampshire:**
  - a. Unanchored/no protection: 2'.
  - b. Anchored/protection: No offset.
  - c. Unanchored/severe drop-off: 2'.
  - d. Anchored/severe drop-off: No offset.
  - e. Explanation of temporary barriers/anchors used: We don't anchor our PCBs. Rather we place a restraining steel section behind the PCB to limit the allowable deflection.
- **North Dakota:**
  - a. Unanchored/no protection: 2'.
  - b. Anchored/protection: [No response.]

- c. Unanchored/severe drop-off: 2'.
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: NDDOT does not anchor barriers down. We adopted the Georgia DOT barrier.
- **Ohio:**
  - a. Unanchored/no protection: Our standards don't currently speak to this space so therefore none required (see guidance above).
  - b. Anchored/protection: Our standards don't currently speak to this space so therefore none required (see guidance above).
  - c. Unanchored/severe drop-off: See Figure 2 in the Portable Concrete Barrier Installation Guidelines drawing.
  - d. Anchored/severe drop-off: See Portable Concrete Barrier Installation Guidelines drawing.
  - e. Explanation of temporary barriers/anchors used: From our Portable Concrete Barrier Installation Guidelines Note 3.
- **South Carolina:**
  - a. Unanchored/no protection: 3 feet.
  - b. Anchored/protection: 1 foot is preferred.
  - c. Unanchored/severe drop-off: 8 feet.
  - d. Anchored/severe drop-off: 5 feet.
  - e. Explanation of temporary barriers/anchors used: Adhesive is only option at this time.
- **Utah:**
  - a. Unanchored/no protection: 1' hard surface and 2' at 8:1 or flatter.
  - b. Anchored/protection: 1'.
  - c. Unanchored/severe drop-off: 1' hard surface and 2' at 8:1 or flatter.
  - d. Anchored/severe drop-off: 1'.
  - e. Explanation of temporary barriers/anchors used: Precast concrete w/pins.
- **Vermont:**
  - a. Unanchored/no protection: [No response.]
  - b. Anchored/protection: [No response.]
  - c. Unanchored/severe drop-off: [No response.]
  - d. Anchored/severe drop-off: [No response.]
  - e. Explanation of temporary barriers/anchors used: See State Standard Drawing T-35&T-36.
- **Virginia:**
  - a. Unanchored/no protection: The deflection distance is generated by the [manufacturer's] deflection distance noted in their data sheets. 100% derived per manufacturer and lengths of barriers.
  - b. Anchored/protection: 0 deflection.
  - c. Unanchored/severe drop-off: If the drop off is in the Deflection zone of the barrier that is in place this scenario is 100% disallowed. Distance must be greater than the deflection area which greatly varies between types of barriers.
  - d. Anchored/severe drop-off: This TOTALLY depends on the type of barrier bolting [system. In] our state we require that bolting on bridges must use barriers with all anchoring done from the

front of the barrier leaving over 12 inches of concrete to help maintain pull out strength and our systems bolt completely [throughout] the deck unless approved by the engineer. If you folks have barriers that bolt front and back you would need 12 inches of concrete behind the barrier for strength of deck (Bolt may pull out if concrete fails).

- e. Explanation of temporary barriers/anchors used: We use several manufacturers for our barrier but our anchoring system is a bolt thru on decks unless it is a 2 phase deck then we use epoxy systems or [H]ilti systems and test the pull out strength of the connection. We pin barriers when we are on roadway surfaces (Grade). We utilize 1 inch pins with 24 inch embedment.
- **Washington:**
  - a. Unanchored/no protection: 2'.
  - b. Anchored/protection: See our Standard Plans.
  - c. Unanchored/severe drop-off: 3'.
  - d. Anchored/severe drop-off: See our Standard Plans.
  - e. Explanation of temporary barriers/anchors used: See our Standard Plans.
- **Wisconsin:**
  - a. Unanchored/no protection: 4' 45 mph or more, 2' less than 40.
  - b. Anchored/protection: no language as of yet.
  - c. Unanchored/severe drop-off: 4' 45 mph or more. 2' less than 40,
  - d. Anchored/severe drop-off: min. 6" back from edge.
  - e. Explanation of temporary barriers/anchors used: bolt through deck, adhesive anchors and ac pin.
- **Wyoming:**
  - a. Unanchored/no protection: 4.
  - b. Anchored/protection: 0.
  - c. Unanchored/severe drop-off: 4.
  - d. Anchored/severe drop-off: 2-4.
  - e. Explanation of temporary barriers/anchors used: See Kansas pinned portable details. [Note: Survey respondent did not provide this information.]

## 5. Overlap

- **Arkansas:** Not as standard practice. If it were to be done it would be the distance necessary to protect, or a 50 foot minimum.
- **California:** Overlap by 20 feet (1 stick min).
- **Delaware:** Yes. Depends on the system that is being overlapped. It is a function of the design deflection of the system. For example, if overlapping behind guardrail, the end of the barrier must be more than 4 feet away from the guardrail to account for guardrail deflection. We have moved away from this and are now requiring guardrail-to-barrier connections in most cases.
- **Florida:** Yes, FDOT allows overlapping which is typically 6 units (12.5' long) totaling approximately 72 feet (see Design Standards, Index 415, Sheets 5 and 6 for other options).
- **Massachusetts:** Depending on site conditions, MassDOT allows either method. If overlapping barriers are used, a minimum of 60' of overlap is required.
- **Michigan:** Yes if it [is] done in a way that protects the endings. We ask for at least one full section of barrier wall to overlap. However, the decision to attach or overlap the temporary barrier is evaluated by



MDOT on a case-by-case [basis], and the decision may vary by location depending on site-specific circumstances.

- **Minnesota:** Current MnDOT practice is to try for a minimum of 50' overlap with a 12" spacing between Barrier runs.
- **Montana:** No, must be attached.
- **Nebraska:** We have in the past—at least 2 barriers past the end.
- **New Hampshire:** Yes to overlapping other PCB barrier and only in short term situation to GR. Usually only one or two lengths of barrier are overlapped depending on the allowable room.
- **North Dakota:** Will overlap in front of barriers or guardrail. No formal policy on length.
- **Ohio:** Per our Transportation Engineering Manual [page 6-49 of the manual, page 49 of the PDF]:

#### 605-14.5.2 End Treatment

The exposed end of the PB [portable barrier] should be located at a distance from the edge of the traveled way equal to the clear zone distance for the facility as discussed in L&D Manual Volume 1, Section 600.2. When this is not practical, impact attenuators shall be provided on the exposed ends of PB located within the clear zone.

Except as noted, exposed ends of PB located outside the clear zone shall be tapered. The leading end of PB does not need be tapered if shielded by another run of overlapping PB, permanent concrete barrier, or fully anchored guardrail (with anchor assembly). However, the PB should extend/overlap at least 50 feet with a guardrail end. Connections or field transitions to guardrail are not crashworthy and are not permitted. Abutting or connecting PB to permanent concrete barrier or parapets is non-standard and requires special anchoring and design details. See Traffic SCD MT-101.80 for design guidance for transitioning portable concrete barrier (does not pertain to portable steel barriers) to permanent concrete barrier.

For acceptable flare rates for PB, see L&D Manual Volume 1, Figure 602-1 and the SCDs [Standard Construction Drawings]. See Section 620-2 for information on the NCHRP 350 requirements.

- **South Carolina:** Barrier overlapping barrier must be at least 1 section. Barrier overlapping guardrail must be attached in accordance with standard drawings.
- **Utah:** Yes, distance not defined.
- **Vermont:** We do not overlap barrier unless it is guard rail overlapping/attached to temporary concrete barrier.
- **Virginia:** Yes we do overlap. That detail is in the VAWAPM which addresses numerous configurations.
- **Washington:** This is done at times. Usually a few barrier sections if they are near the existing barrier. I do not think we have a standard. Length of need calculations should be done in other cases to protect blunt ends.
- **Wisconsin:** Overlap over other temporary barriers. Current overlap 8 barrier sections.
- **Wyoming:** Yes, 9 barrier sections.

## 6. Head-to-head protection

- **Arkansas:** We utilize this configuration on interstate rehabilitation projects where one set of lanes is closed on a four lane divided freeway.

- **California:** Design is working to develop some criteria.
- **Delaware:** We rarely use barrier for head-to-head protection mainly due to space constraints. Typically use is based on speed of traffic. We require it on limited access high speed highways. Case-by-case on other roadways.
- **Florida:** Assuming you are referring to placing the barrier between opposing lanes of traffic, then yes but they are not permitted to be anchored (see Design Standards, Index 414 and 415).
- **Massachusetts:** Assuming “head-to-head” means separation of two way traffic, yes. MassDOT requires the space between the barrier face and the yellow edge line meet or exceed the tested permanent deflection value.
- **Michigan:** On all freeways that are on the same roadbed.
- **Minnesota:** MnDOT will generally not use a portable concrete barrier for single lane traffic in each direction. It will instead separate using tube delineators, temporary raised pavement markers, and striping. However, there are specific freeways in the Twin Cities Metropolitan area for which a portable concrete barrier is used for single lane traffic in each direction. A portable concrete barrier will also be used when separating multiple lanes in each direction. When a portable concrete barrier is used, 2 feet is the desired inside shoulder for each direction and it is generally not anchored.
- **Montana:** No, Montana Department of Transportation does not use TCB for head to head traffic.
- **Nebraska:** We only use barriers for head to head when there are 2 lanes or more in each direction.
- **New Hampshire:** We follow the guidance of the Roadside Design Guide and the MUTCD for all temporary protection.
- **North Dakota:** No formal policy. On a project by project basis if requested by Highway Patrol, NDDOT District or some other entity. [Then] it will be considered and discussed.
- **Ohio:** Per our Transportation Engineering Manual Section 605-14.1 [page 6-47 of the manual, page 47 of the PDF]:

At a minimum, temporary traffic barriers shall be considered in work zone situations that place workers at increased risk from motorized traffic, and where these barriers offer the highest potential for increased safety for workers and road users, such as:

1. The work zone provides no means of escape for workers (e.g., tunnels and bridges). Adjacent lanes, carrying traffic flowing in opposite directions on Interstates, freeways, and other high-speed (>45 miles per hour) multi-lane divided highways (see Traffic SCDs MT-95.70, MT-95.71, MT-95.72, and MT-95.73).

Portable barrier is the only separation option shown in the Standard Construction Drawings MT-95.70, MT-95.71, MT-95.72, and MT-95.73.

MT-95.70

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09570\\_2013-07-19.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09570_2013-07-19.pdf)

MT-95.71

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09571\\_2013-07-19.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09571_2013-07-19.pdf)

MT-95.72

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09572\\_2017-01-20\\_.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09572_2017-01-20_.pdf)

MT-95.73

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09573\\_2017-01-20.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09573_2017-01-20.pdf)

- **South Carolina:** At all times when opposing directions of travel normally separated by an earth median are temporarily located in a “head to head” configuration.
- **Utah:** Any inte[r]state or high steep requires barrier. Standard Drawing [TC] 7, see link above [page 414 of the PDF].
- **Vermont:** Not sure. This terminology is unfamiliar to me.
- **Virginia:** Yes we do use it. Determined by values in [A]ppendix [A] of VAWAPM.
- **Washington:** Based on project specific needs. Same for Question [No. 5].
- **Wisconsin:** Don’t understand the term.
- **Wyoming:** Part of standard plans interstate. No formal guidance.

## **7. Criteria for temporary barrier use**

- **Arkansas:** MUTCD [Manual on Uniform Traffic Control Devices], AASHTO Roadside Design Guide.
- **California:** Design is still working on the criteria.
- **Delaware:** See provided Design Guidance and DE [Delaware] MUTCD regarding criteria for use. Generally, use is based on proximity to high speed traffic, traffic volumes, type, location and duration of work activities, lack of escape route for workers and protection of fixed objects/work activities.
- **Florida:** FDOT doesn’t have specific guidance for the use of barriers to provide positive protection solely to protect workers, but guidance is provided for when barriers are required to protect motorists [from] hazards (reference PPM Ch. 4.4 and Design Standards, Index 600).
- **Massachusetts:** The barrier is required to protect from a drop-off under all conditions. For fixed objects, an evaluation is made regarding whether the TTC setup increases the exposure of the fixed object and, if so, if it is most effective to remove it, protect it with attenuation, make it crashworthy, or protect it with barrier.
- **Michigan:** MDOT Usage Criteria - Temporary longitudinal barrier shall be used: On all freeway projects where opposing traffic lanes are adjacent to each other or when dividing bi-directional traffic on roadways where the posted speed limit prior to construction is 50 mph or higher. Temporary longitudinal barriers are not required on projects where motorists and non-motorized traffic lanes are adjacent to each other when a non-mountable curb is in place. Work Zone Safety Mobility Manual Page 17-1 thru 17-2:  
([http://www.michigan.gov/documents/mdot/MDOT\\_WorkZoneSafetyAndMobilityManual\\_233891\\_7.pdf](http://www.michigan.gov/documents/mdot/MDOT_WorkZoneSafetyAndMobilityManual_233891_7.pdf)). This will be changing in the near future.
- **Minnesota:** MnDOT will use typically use a portable concrete barrier in long term projects (duration greater than 3 days) that have large drop offs or hazards, and to protect workers.
- **Montana:** Drop-off specification.
- **Nebraska:** Work duration and type of work are the main criteria we use.

- **New Hampshire:** The criteria [are] contained in our Positive Protection Guidance for Work Zones. Link provided in question [No. 1].
- **North Dakota:** Typically no barrier is less than two weeks. It also depends on the obstruction or dropoff. If no escape route for workers [then] barrier is used such as on a bridge.
- **Ohio:** 605-14 Temporary Traffic Barriers [page 6-47 of the manual, page 47 of the PDF]:

#### 605-14.1 General

Temporary traffic barriers are devices designed to help prevent penetration by vehicles while minimizing injuries to vehicle occupants, and designed to protect workers, bicyclists and pedestrians (see OMUTCD Section 6F.85). More specific information on the use of temporary traffic barriers is contained in AASHTO's Roadside Design Guide.

Because the protective requirements of a temporary traffic control situation have priority in determining the need for temporary traffic barriers, their use shall be based on an engineering study.

At a minimum, temporary traffic barriers shall be considered in work zone situations that place workers at increased risk from motorized traffic, and where these barriers offer the highest potential for increased safety for workers and road users, such as:

1. The work zone provides no means of escape for workers (e.g., tunnels and bridges). Adjacent lanes, carrying traffic flowing in opposite directions on Interstates, freeways, and other high-speed (>45 miles per hour) multi-lane divided highways (see Traffic SCDs MT-95.70, MT-95.71, MT-95.72, and MT-95.73).
2. Long-term work zones (e.g., two weeks or more).
3. Workers close to travel lanes open to traffic.
4. Drop-off areas (see Traffic SCD MT-101.90).
5. Projects with high operating speeds and high traffic volumes.
6. Bridge decks where the parapet or guardrail is removed (see SCD PCB-91 and the Design Data Sheet PCBDD on the Office of Structural Engineering Publications web page).

Warning lights or steady-burn electric lamps may also be mounted on temporary traffic barrier installations. When serving the additional function of channelizing vehicular traffic, temporary traffic barriers should be a light color for increased visibility.

#### 605-14.2 Length of Need

The method used to design the length of need and location of barrier for maintenance of traffic applications should be as discussed in L&D Manual Volume 1, Sections 602.1.2 and 602.1.3 for determining barrier length.

Length of need typically does not include attenuators, thus work zone design must take this into account.

There is also the Standard Construction Drawing for Impact Attenuator Placement (MT-101.75) that discusses length of need.

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_10175\\_2016-07-15.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_10175_2016-07-15.pdf)

- **South Carolina:** Proximity and severity of drop-offs and at all times when travel lanes normally separated by an earth median are temporarily located in a “head to head” configuration.
- **Utah:** Standard Barrier TC-3B. UDOT Policy 08-05.
- **Vermont:**
  - a. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt11.pdf>
  - b. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt12.pdf>
  - c. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt13.pdf>
  - d. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt14.pdf>
  - e. <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdt15.pdf>
- **Virginia:** That is determined in the time/need formula in [A]ppendix A of the VAWAPM.
- **Washington:** See our Design Manual Chapter 1010.10.
- **Wisconsin:** See 11-50-53.
- **Wyoming:** Protection of vertical drop offs.

## **8. Installation near curb**

- **Arkansas:** Refer to standard drawing.
- **California:** [No response.]
- **Delaware:** Typically, the barrier is placed against the face of the curb.
- **Florida:** Only if there is enough deflection space between the barrier and curb as outlined in our Design Standards.
- **Massachusetts:** Under high speed conditions the curb is most often considered an object that will impede deflection; a barrier with less deflection or placement of the barrier behind the curb is required. Low-speed conditions are examined on a case-by-case basis depending for geometric constraints, probability of impact, etc.
- **Michigan:** This would have to be evaluated on a case-by-case basis by MDOT, since MDOT does not have specific guidelines addressing this topic. Items that MDOT would take into consideration include: curb type, prevailing speeds, duration of barrier wall placement, traffic volumes, location (e.g., urban/rural, etc.), length of curb being impacted, extent of work required to replace the curb, other work items that would be required in order to replace the curb, etc. Obviously, the decision will vary by location and will be site-specific.
- **Minnesota:** MnDOT tries to avoid installing a portable concrete barrier near the curb; however, if engineering judgment deems the portable concrete barrier necessary near the curb, it is installed either all on top of the curb or butted up to the curb. This would only be for a portable concrete barrier as the other temporary barrier types generally require anchoring.

- **Montana:** No.
- **Nebraska:** The barrier is typically placed on top of the curb (or behind the curb) if possible.
- **New Hampshire:** We don't always consider the presence of curb when designing temporary barrier. On many occasions I have seen the PCB placed up and over the curbing, creating sharp and difficult connection points between PCB sections.
- **North Dakota:** Barrier is set in front if 2' is not provided.
- **Ohio:**  
We do not have any specifications for these situations. For the placement of impact attenuators see the excerpt below:

From the Location and Design Manual Volume 1 [page 6-10 of the manual, page 14 of the PDF]:

#### 602.1.5.3 End Treatments and Impact Attenuators in Curbed Sections

None of the approved anchor assemblies or impact attenuators listed in Sections 603.3 and 603.4 have been designed or tested for use with curbs; consequently, the designer should use the guidelines provided for uncurbed sections in addition to engineering judgment and recommendations from the manufacturer to select end treatments in curbed sections. The current recommendation from product vendors is to ensure curbs are not present (if practical) along the length of the product and for a distance of 50 feet in advance of the product. When terminating or removing curbs in the vicinity of end treatments and impact attenuators remember to taper the curb height from 4 or 6 inches to flush with the pavement over a distance of 10 feet.

- **South Carolina:** We have no specific requirements.
- **Utah:** Along the face of the curb.
- **Vermont:** We follow, if any, recommendations established in the Roadside Design Guide.
- **Virginia:** This is such a broad thought it is hard to answer. Examples if there is room we put it in front of the curb: If there isn't enough lane we may remove the curb set barrier and repour curb when barrier is removed: We also set barrier on utility strip above curb. This is totally developed per job basis.
- **Washington:** Not sure. Barriers are not often used on this type of highway.
- **Wisconsin:** We tell people to avoid placing near curb.
- **Wyoming:** Try to avoid placing next to curb.

### 9. Clear zone distance in work zones

- **Arkansas:** No.
- **California:** No.
- **Delaware:** Yes. See DE MUTCD, Table 6G-1 related to vertical differences.
- **Florida:** Yes. Reference Table 4.2.1 and 4.2.2 in Chapter 4 of the PPM.
- **Massachusetts:** No.
- **Michigan:** No.
- **Minnesota:** MnDOT generally uses a 30' clear zone for speeds greater than 55mph in construction zones, whether in tangent or horizontal curvature. Otherwise, Table 9-1 of the AASHTO Roadside Design Guide is used as a resource.
- **Montana:** Yes. Dependent of speed and ADT.

- **Nebraska:** Yes. We use the guidance from the Roadside Design Guide.
- **New Hampshire:** No.
- **North Dakota:** No.
- **Ohio:** Yes. Table 600-1E in the Location and Design Manual Volume 1 Section 600 is the table for permanent clear zone widths, and it takes into account speed, volume, foreslope, backslope, and horizontal curve correction factors. The work zone standard construction drawings that discuss clear zone include a much more simplified table that is only based on speed. The links to the publications are below. [Figure] 600-1E in the Location and Design Manual (page 36 of the PDF):

Volume 1 Section 600

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section\\_600\\_Jan\\_2017.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location%20and%20Design%20Manual/Section_600_Jan_2017.pdf)

MT-95.40 Table II

[http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT\\_09540\\_2017-01-20\\_.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/SCD/Documents/MT_09540_2017-01-20_.pdf)

- **South Carolina:** Yes. The end must be protected by an attenuator unless the approach section is tapered away at a rate of 10:1 to a point that locates the end 30 feet from the near edge of the approaching travel lane or the approach section is tapered away at a rate of 8:1 to a point that locates the end 15 feet from the near edge of the opposing travel lane for speeds of 40 and less.
- **Utah:** Yes. Dependent on speed. Standard Drawing TC-3B.
- **Vermont:** We follow recommendations established in the Roadside Design Guide Chapter 9.
- **Virginia:** No. Clear Zone distances are noted on page A4 in Appendix A of the VAWAPM.
- **Washington:** Yes. See: [http://www.wsdot.wa.gov/publications/fulltext/projectdev/gspspdf/1-07.23\(1\).OPT2.GR1.PDF](http://www.wsdot.wa.gov/publications/fulltext/projectdev/gspspdf/1-07.23(1).OPT2.GR1.PDF).
- **Wisconsin:** Yes. See 11-50-53.
- **Wyoming:** Yes. 15.

#### **10. Alternatives to anchoring PCBs**

- **Arkansas:** [No response.]
- **California:** [No response.]
- **Delaware:** None at this time. We are aware of a NYDOT crash tested system that utilizes box beam guardrail elements on the work zone side of the barrier to provide stiffening. We have considered the use of such a system but have not done so yet. PennDOT also has tested something similar.
- **Florida:** FDOT does not have un-anchored alternative to our standard deflection requirements.
- **Massachusetts:** The TxDOT X-bolt barrier is the only system we are aware of that requires no anchoring and minimizes deflection. The NY State DOT barrier that has a box beam stiffener on the non-traffic side is pinned only at the ends of the run and has a relatively low deflection value.
- **Michigan:** Box beam stiffeners as detailed in R-53.
- **Minnesota:** MnDOT has not tried the two runs of barrier, but would be interested if other states have done so.
- **Montana:** None.

- **Nebraska:** We typically provide enough space behind the barriers to avoid anchoring them into new pavements or bridge decks.
- **New Hampshire:** We have a PCB braced barrier detail that we have been using for some time. We used to anchor the PCB on our decks but had to come up with an alternative as we didn't want to core into new decks. (See [Appendix A](#).)
- **North Dakota:** No alternatives used. Take other actions to provide for the 2' requirements such as close lane or detour.
- **Ohio:** We don't have any specific methods for avoiding anchoring.
- **South Carolina:** We do not anchor walls on new pavements.
- **Utah:** Require deflection difference. Sadly we have the same problem. We view as construction phasing problems.
- **Vermont:** None that I know of.
- **Virginia:** Please review VAWAPM. [I]t details how to do this with sand bags between two individual runs. VDOT's Road and Bridge standards book Volume I page 502.04. Please call if you have any questions.
- **Washington:** None that I am aware of other than trying to stage the work so anchoring is not required or not done on final roadway surface.
- **Wisconsin:** WisDOT is currently researching developing a crashworthy low deflection barrier system.
- **Wyoming:** [No response.]

## **State Resources**

**Traffic Control Plans Design Manual**, 12th edition, Oregon Department of Transportation, May 2016.

[http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/tcp\\_manual/TCP\\_DM\\_Edition\\_12\\_Chapter3.pdf](http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/docs/pdf/tcp_manual/TCP_DM_Edition_12_Chapter3.pdf)

Chapter 3 of this manual focuses on positive protection, including a decision tree.

**Chapter 16, Maintenance and Protection of Traffic in Highway Work Zones**, Highway Design Manual, New York State Department of Transportation, April 2016.

[https://www.dot.ny.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt\\_16.pdf](https://www.dot.ny.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt_16.pdf)

This chapter provides New York state policies for positive protection in work zones.

**Work Zone Positive Protection Guidelines for Idaho**, Idaho Transportation Department, December 2014.

<https://ntl.bts.gov/lib/55000/55100/55103/RP228WorkZoneFinal01122015.pdf>

*From the abstract:*

This project developed Idaho-specific work zone positive protection guidelines that Idaho Transportation Department (ITD) staff can use when designing work zone traffic management plans. The guidelines address conditions where positive protection device (i.e. devices that contain and/or redirect vehicles and meet the federal crashworthiness evaluation criteria) application can be recommended on the basis of reduced work zone crash costs. For sites where such conditions do not exist, guidelines are provided regarding intrusion and crash reduction countermeasures (e.g., closer channelizing device spacing and supplemental speed management devices) that could be employed. These guidelines are based on the theory of encroachment hazard analysis, which was conducted using the Roadside Safety Analysis Program (Version 3, NCHRP 22-27, 2012).



**Work Zone Positive Protection Guidelines**, Texas Department of Transportation, May 2011.

<http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/0-6163-1.pdf>

*From the abstract:*

The goal of this project was to develop implementation guidance that the Texas Department of Transportation (TxDOT) can use to make better decisions regarding when and where to use positive protection in work zones and when to consider exposure control and other traffic control measures that could improve work zone safety. The specific objectives of the project were as follows: analyze the benefits and costs of using portable concrete barrier (PCB) for positive protection in work zones, analyze the benefits and costs associated with the use of moveable and portable barrier technologies that can be more quickly deployed and removed at work sites than traditional PCB, analyze the benefits and costs of non-positive protection devices that can be used to improve safety and reduce work zone intrusion events in work zones, and develop implementation guidelines for these various technologies. Researchers also developed guidelines for portable concrete barrier use in work zones. Guidelines regarding the use of portable steel barrier, mobile barrier, and truck-mounted attenuators were also developed. General guidance and information regarding the use of exposure control measures and other traffic control measures to reduce work space intrusion risks were also included in this report.

**Guidelines for the Use of Positive Protection in Work Zones**, Colorado Department of Transportation, January 2010.

[http://www.mobilebarriers.com/images/CO\\_Guidelines\\_Positive\\_Protection\\_122809.pdf](http://www.mobilebarriers.com/images/CO_Guidelines_Positive_Protection_122809.pdf)

This document presents Colorado DOT guidelines on the use of positive protection devices in work zones.

**Guidelines for the Use of Positive Protection in Work Zones**, North Carolina Department of Transportation, April 2009.

[https://connect.ncdot.gov/projects/wztc/Documents/Pos\\_Protection.pdf](https://connect.ncdot.gov/projects/wztc/Documents/Pos_Protection.pdf)

These guidelines address North Carolina's use of positive protection in compliance with FHWA Final Rule Subpart K to CFR Part 630.

## **National Resources**

**Work Zone Traffic Management**, Federal Highway Administration, last modified February 5, 2017.

[https://ops.fhwa.dot.gov/wz/traffic\\_mgmt/](https://ops.fhwa.dot.gov/wz/traffic_mgmt/)

The Federal Highway Administration's Work Zone Mobility and Safety Program traffic management Web page contains links to resources for work zone traffic management, including positive protection:

[https://ops.fhwa.dot.gov/wz/construction/pos\\_separation.htm](https://ops.fhwa.dot.gov/wz/construction/pos_separation.htm)

**Guidelines for Temporary Traffic Control in Work Zones**, Federal Highway Administration, March 2009.

[https://www.t2center.uconn.edu/pdfs/Work%20Zone%20Safety%20Guidebook\\_Final.pdf](https://www.t2center.uconn.edu/pdfs/Work%20Zone%20Safety%20Guidebook_Final.pdf)

*From the introduction:*

This handbook gives the basic principles and provides examples for the design, application, installation, and maintenance of the various types of traffic control devices used in temporary traffic control or for incident management. This information is intended to provide the principles of proper work zone traffic control, but is not a standard. Part 6 of the MUTCD contains the standards for work zone traffic control.

**Work Zone Positive Protection Toolbox**, American Traffic Safety Services Association, 2009.

<https://www.workzonesafety.org/publication/work-zone-positive-protection-toolbox/>

*From the abstract:*

This brochure highlights five positive protection countermeasures, including Portable Concrete Barriers, Movable Concrete Barriers, Ballast Filled Barriers, Shadow Vehicles, and Vehicle Arresting Systems. The toolbox describes how to use each countermeasure and provides guidance for their use. It also describes the various types of positive protection countermeasures currently in use and provides guidance on where and how each is typically used. This toolbox is intended to be a reference for designers, policy makers, specification writers, and field personnel.

**Work Zone Operations Best Practices Guidebook**, Federal Highway Administration, 2013.

<http://ops.fhwa.dot.gov/wz/practices/best/bestpractices.htm>

This guidebook “provides an easily accessible compilation of work zone operations practices used and recommended by various States and localities around the country for effectively managing work zones and reducing the impacts of work zones on mobility and safety.”

**NCHRP Report 553: Crashworthy Work-Zone Traffic Control Devices**, Roger Bligh, Wanda Menges and Rebecca Haug, 2006.

[http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_553.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_553.pdf)

*From the introduction:*

The objective of this research was to develop nonproprietary, crashworthy work-zone traffic control devices that are easily constructed of readily available materials.

**A Guide for Reducing Work Zone Collisions**, Nicholas Antonucci, Kelly Hardy, James Bryden, Timothy Neuman, Ronald Pfefer and Kevin Slack, Vol. 17, NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, 2005.

[http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_500v17.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v17.pdf)

*From the foreword:*

This seventeenth volume of NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan provides strategies that can be employed to reduce work zone crashes. The report will be of particular interest to safety practitioners with responsibility for implementing programs to reduce injuries and fatalities on the highway system.

## **Related Research and Other Resources**

**Work Zone Crash Characteristics and Countermeasure Guidance**, NCHRP Project 17-61, expected completion date: April 2017.

<http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3183>

*From the project description:*

The objective of this research is to develop comprehensive guidance on the characteristics of work zone crashes and the effectiveness of countermeasures in various categories (such as engineering, enforcement, education, Emergency Medical Services, and public policy) to reduce work zone crash frequency and severity, and improve overall work zone safety.

**Portable Positive Protection: A Guide for Short Duration and Short Term Work Zones**, American Traffic Safety Services Association, September 2015.

[https://www.workzonesafety.org/files/documents/training/fhwa\\_wz\\_grant/atssa\\_portable\\_positive\\_protection.pdf](https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_portable_positive_protection.pdf)

*From the abstract:*

Transportation agencies, contractors, researchers, and private vendors are actively looking for new methods and devices to help make construction and maintenance work zones safer while maximizing mobility. Short-term and short-duration work zones are no exception, especially as fewer devices can be used in a practical way than in long-term work zones due to the limited installation time available. Practitioners commonly cite the challenge of using traditional devices for protection, as installation costs are high relative to the project and it may take longer to install the devices than perform the planned activities. This situation creates the need for more portable positive protection devices in lieu of traditional devices (such as temporary concrete barrier or “TCB”) that are commonly used on long-term projects, but can’t be repositioned easily. This document looks at why portable positive protection should be used and examines types of portable positive devices currently available such as: highly mobile barriers, movable steel barriers, and protective vehicles. It also examines the cost benefits of portable positive protection and includes ten suggested steps to take when planning to use portable positive protection.

**“Evaluation of a Mobile Work Zone Barrier System,”** Nicholas Tymvios and John Gambatese, *Construction Research Congress 2014*, May 2014.

Citation at: <http://trid.trb.org/view/1309201>

*From the abstract:*

A recent advancement in work zone safety includes the use of a mobile barrier system (MBS) that can be transported to a work zone and provides positive protection to maintenance crews, with minimum effort and in a very short time. The Oregon Department of Transportation (ODOT) recently purchased such a barrier and, with the limited independent literature available as to the effectiveness of its use in work zones, contracted with researchers at Oregon State University to evaluate the MBS. The research team investigated the barrier during five case studies that were representative of ODOT maintenance activities for various performance metrics, such as time of setup, limitations/enhancements to work operations, worker safety and safety perception, worker productivity, and motorist safety perception. The same performance metrics also were investigated in similar maintenance operations without the MBS present. The results show that the MBS provides enhanced protection to the workers by reducing and eliminating hazards and providing a positive barrier between the work area and passing traffic. The barrier facilitates work operations by enhancing worksites with additional lighting, noise protection, power capabilities, and storage compartments. Additional training is needed for the work crews so that they can fully seize the true potential of the barrier for efficiency.

**“Work Zone Positive Protection Policy Guidance: Synthesis of Devices and State of Practice,”** Steven Schrock, Eric Fitzsimmons, Tomas Lindheimer, Ming-Heng Wang and Yong Bai, TRB 93rd Annual Meeting, Paper #14-5574, 2014.

<http://docs.trb.org/prp/14-5574.pdf>

*From the abstract:*

This research study first investigated temporal trends in national and Kansas work zone related crash trends, specifically crashes involving striking a construction vehicle or fixed object. Additionally, current work zone Test Level Three and Two (TL-3 and TL-2) approved positive protection devices were summarized including longitudinal barriers, mobile barriers, vehicle arresting systems and end

protection systems. Next, a nationwide survey of state highway agencies was conducted to summarize current guidance relating to positive protection or changes in guidance to comply with Temporary Traffic Control Devices 23 CFR 630 Subpart K. Finally, the research study provided preliminary work zone positive protection guidance for the Kansas Department of Transportation based on the findings of the survey and currently commercially available products.

**“Benefit-Cost Analysis of Portable Concrete Barrier Use in Work Zones to Protect Against Intrusion Crashes,”** Vichika Iragavarapu and Gerald Ullman, *TRB 91st Annual Meeting Compendium of Papers DVD*, Paper #12-1840, 2012.

Citation at: <http://trid.trb.org/view/1129487>

*From the abstract:*

The objective of this study was to evaluate the benefits and costs associated with the use of portable concrete barriers (PCBs) in work zones to protect workers and equipment against intrusion crashes. This study used an encroachment-based tool; the Roadside Safety Analysis Program (RSAP) to perform the analysis. Researchers customized certain aspects of RSAP to make it more suitable for a work zone analysis. This included current PCB costs, comprehensive crash costs, and adjustment to encroachment rate to represent a work zone situation. Unlike previous efforts that modeled individual workers and equipment as spot hazards, researchers chose to represent the entire work area as a single hazard for this study. The analysis found that for high speed multilane freeway facilities where work is occurring immediately adjacent to travel lanes, intrusion crash costs savings alone can justify PCB protection once the roadway ADT approaches 40,000 vpd over a year-long work zone, so long as there are constant hazards in the work space being protected by barrier.

**“Functional Requirements for Highly Portable Positive Protection Technologies in Work Zones,”** Gerald Ullman, Melisa Finley and Dean Alberson, *TRB 86th Annual Meeting Compendium of Papers CD-ROM*, Paper #07-1690, 2007.

Citation at: <http://trid.trb.org/view/801818>

*From the abstract:*

This paper describes a set of functional requirements developed for highly-portable positive protection technologies that protect highway workers. These requirements were based on an assessment of a large number of construction and maintenance work activities that are highly mobile and thus would potentially benefit from such a system. Specific roadway design features believed to have the most significant impact upon the functional requirements of a highly-portable positive protection system were also considered. While it is desirable to have a protective device that covers a wide possibility of work zone conditions, this preliminary study shows there are some practical limits to activities that can be accommodated by a single type of highly-portable positive protection device. As defined, a protection system meeting the stated requirements could accommodate about two-thirds of the construction and maintenance activities considered. Perhaps a highly-portable positive protection system could be used during some of the remaining activities if work crews were to adopt slightly different procedures for those activities.

**Optimizing Work Zone Practices for Highway Construction Projects,** Tarek Maged Elghamrawy, University of Illinois, Urbana-Champaign, 2011.

Citation at: <http://trid.trb.org/view/1138292>

*From the abstract:*

The research objectives of this study are to: (1) provide enhanced understanding of the impact of work zone parameters and innovative temporary traffic control devices on the safety of highway construction

zones; (2) analyze work zone crashes and current practices to identify potential layout parameters that impact work zone crash occurrence; (3) investigate and quantify the impact of work zone layout parameters on the risk and cost of crash occurrence; (4) optimize work zone setup parameters to minimize total work zone costs including agency, user delay, and expected crash costs; (5) conduct field experiments to analyze the efficiency and constructability of various arrangements of temporary rumble strips prior to and at the edge of work zones; and (6) study and enhance the effectiveness of temporary rumble strips in alerting inattentive drivers prior to and at the edge of work zones.

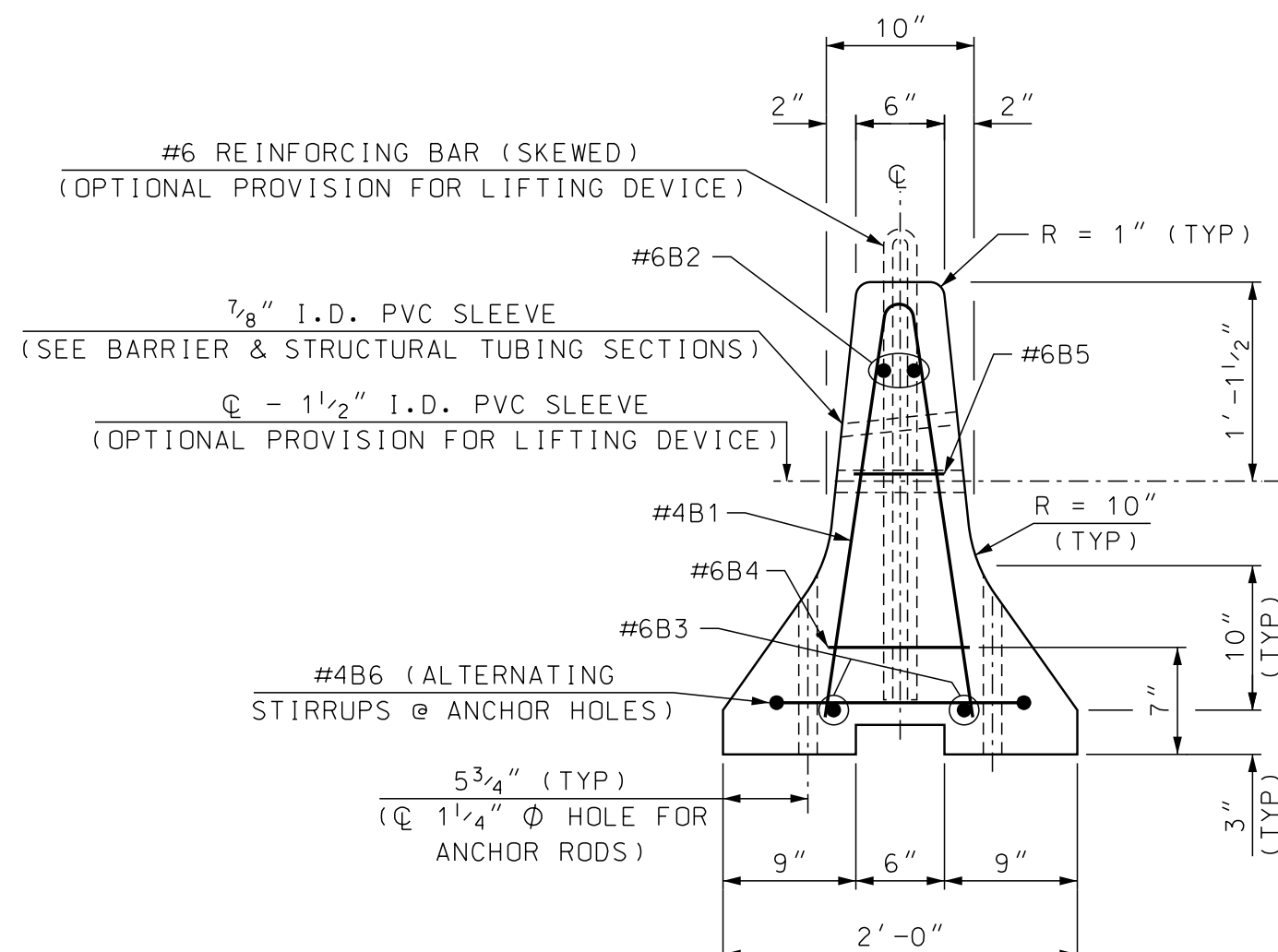
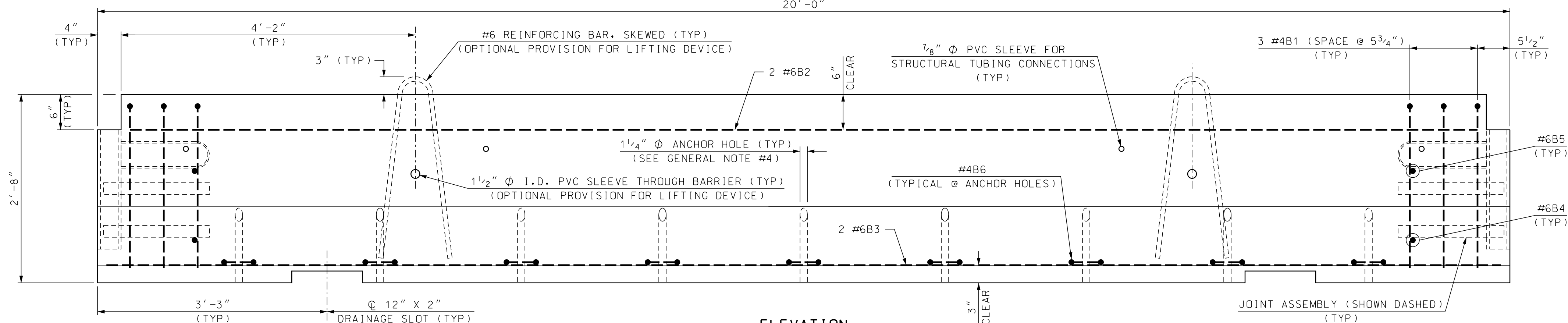
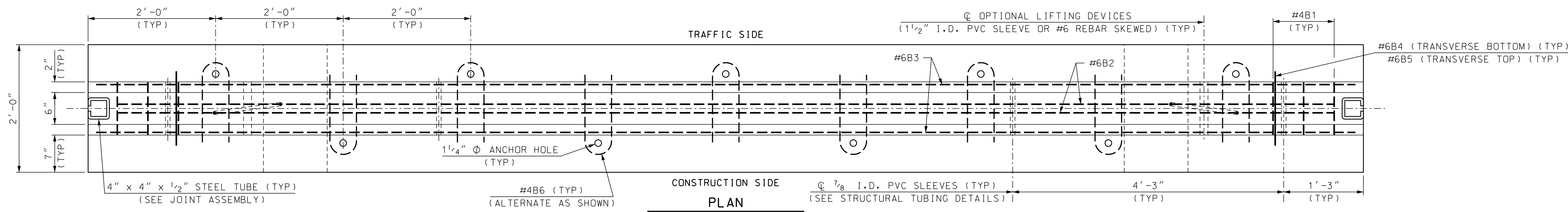
**“Placement Guidance for Temporary Concrete Barriers in Construction Work Zones: Developed with Roadside Safety Analysis,”** Richard Porter, Kevin Mahoney and Gerald Ullman, *Transportation Research Record 1984*, pages 21-30, 2006.

Citation at: <http://trid.trb.org/view/777341>

*From the abstract:*

The objective of this paper is to investigate and evaluate the information, tools, and procedures available to aid individual designers and agencies in developing guidance for the use of traffic barriers in construction work zones. Principles of roadside barrier use for permanent roadways will be covered. Also covered will be benefit–cost analysis and adaptation of permanent roadway procedures and programs, specifically the Roadside Safety Analysis Program (RSAP), for the purpose of developing work zone barrier guidance. Results show that the modeling of specific work zone scenarios and development of generalized barrier placement guidance for practitioners based on cost-effective principles are both feasible. This type of analysis can be done by adapting algorithms in RSAP intended for permanent roadway analysis to construction work zones. General guidelines similar to the median barrier warrants for permanent roadways in the “Roadside Design Guide” were developed for construction work zones. In addition, it was concluded that current encroachment models and crash severity indexes may not be well suited for permanent roadways or construction work zones.

## Appendix A



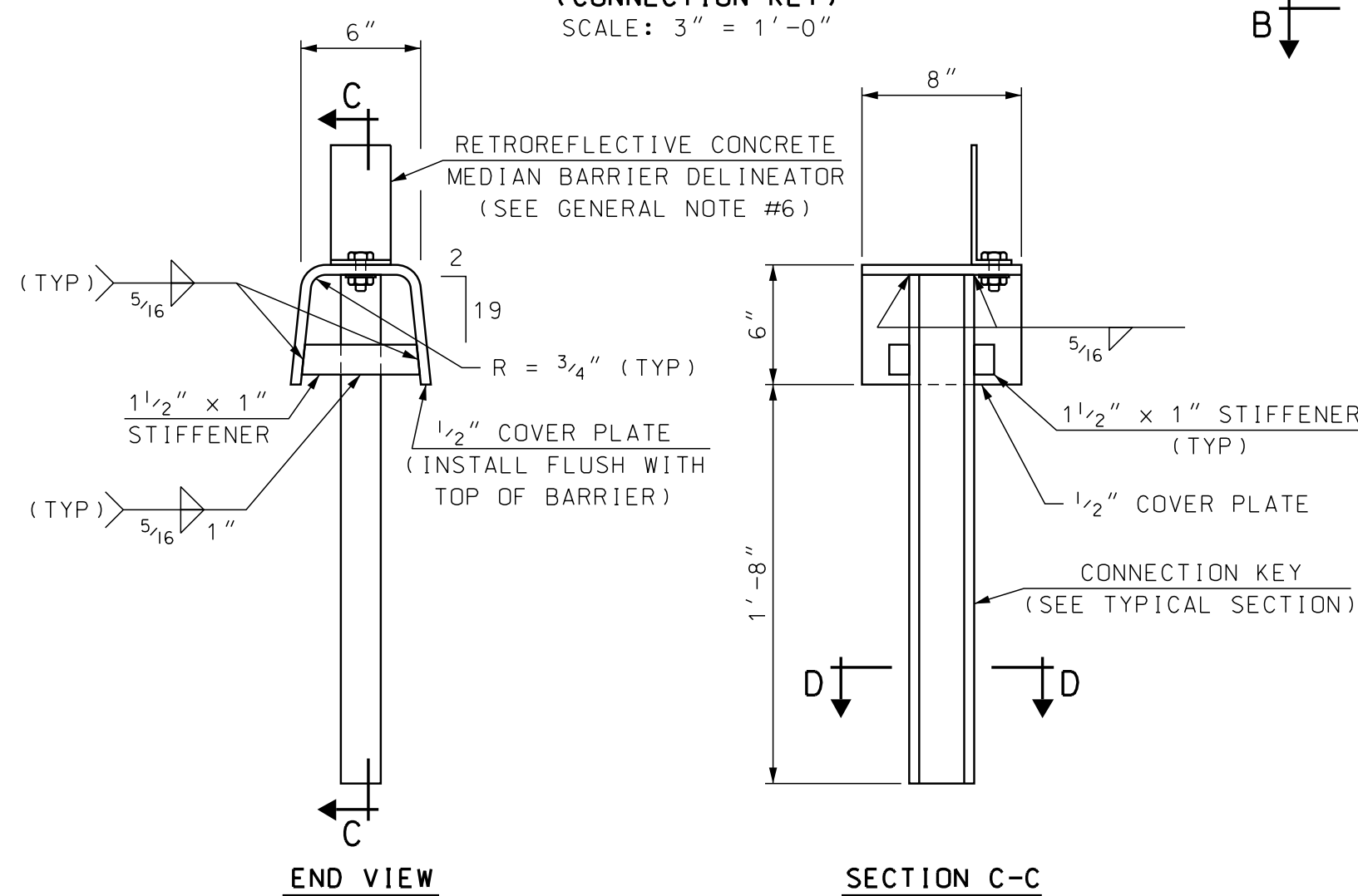
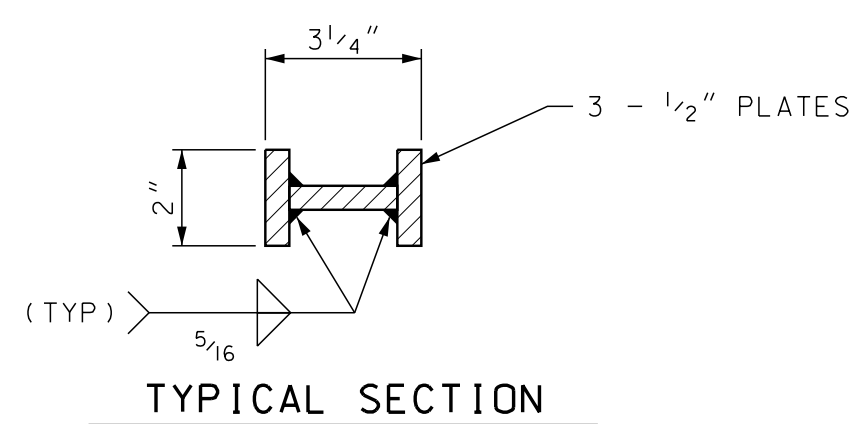
TYPICAL SECTION

## GENERAL NOTES

- (3) PORTABLE CONCRETE BARRIER SHALL BE FURNISHED BY THE CONTRACTOR AND PAID FOR AS ITEM 606.4174. PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL - BRACED. CONCRETE BARRIER AND ALL ATTACHMENTS SHALL BE FABRICATED IN ACCORDANCE WITH SPECIAL PROVISIONS. ALL BARRIER UNITS FOR BRACED SYSTEMS SHALL BE 20' LONG.
- (2) PORTABLE CONCRETE BARRIER DETAILS, AS SHOWN IN THESE PLANS, ARE IN COMPLIANCE WITH REQUIREMENTS PER UPDATED NCHRP REPORT 350 FOR TEST NO. 3-11 (MASH TEST LEVEL 3), CRASH TESTED BY MIDWEST ROADSIDE SAFETY; NY BOX BEAM STIFFENING OF UNANCHORED TCB, MARCH 2008, AND ACCEPTED PER FHWA LETTER B-239 (11/1/2012). THE BARRIER SYSTEM HAS BEEN CRASH TESTED WITH A 27.6" DYNAMIC DEFLECTION WHICH WILL ALLOW BRACED BARRIER TO BE PLACED A MINIMUM 12" FROM THE EDGE OF BRIDGE DECK.
- (3) A MINIMUM OF TWO BARRIER UNITS, WITH BRACED JOINTS ARE REQUIRED TO BE PLACED BEYOND BOTH ENDS OF THE BRIDGE WORK AREA, FOR SPEEDS GREATER THAN 45 MPH. FOR SPEEDS  $\leq$  45 MPH, A MINIMUM OF ONE BRACED BARRIER IS REQUIRED TO BE FULLY SET BEYOND EACH END OF BRIDGE WORK AREA.
- (4) THE LAST CONCRETE BARRIER UNIT, AT EACH END OF BRACED BARRIER LAYOUT, SHALL BE ANCHORED A MINIMUM 18" BELOW THE ROADWAY SURFACE. REQUIRED 1"  $\Phi$  ANCHOR RODS (A36 STEEL) SHALL BE INSTALLED WITH 5 ANCHORS ON THE TRAFFIC SIDE OF BARRIER AND 4 ON THE CONSTRUCTION SIDE. IF THE END(S) OF THE BRACED CONCRETE BARRIER SYSTEM EXTENDS 50' OR MORE BEYOND LIMITS OF BRIDGE WORK THE LAST BARRIER UNIT DOES NOT REQUIRE ANCHORAGE.
- (5) PORTABLE CONCRETE BARRIER - BRACED, ITEM 606.4174, MAY BE INSTALLED WITH A 230' MINIMUM RADIUS. GAPS CREATED BETWEEN STRUCTURAL TUBES AND CONCRETE BARRIER, DURING A RADIAL LAYOUT, SHALL BE SHIMMED WITH 8" x 8" x 1/2" PLATES & FENDER WASHERS TO FIRMLY ATTACH STRUCTURAL TUBING TO BARRIER.
- (6) THE CONTRACTOR SHALL FURNISH AND INSTALL APPROVED RETROREFLECTIVE DELINEATORS AT 25-FOOT INTERVALS ALONG TOP AND/OR ONE FOOT DOWN THE SIDE OF PORTABLE CONCRETE BARRIER, SUBSIDIARY TO ITEM 606.4174 (SEE STANDARD NO. DL-1 OF NHDOT STANDARD PLANS FOR ROAD CONSTRUCTION). THE COLOR OF DELINEATORS SHALL, IN ALL INSTANCES, CONFORM TO THE COLOR OF EDGE LINE MARKINGS. DELINEATORS SUPPLEMENT, BUT DO NOT REPLACE, THE NEED FOR RETROREFLECTIVE SOLID EDGE LINE MARKINGS.

## MATERIAL NOTES

- (1) BARRIERS SHALL BE LIGHT COLORED CLASS AA CONCRETE, WITH MINIMUM COMPRESSIVE STRENGTH OF 4000 psi. AND SHALL HAVE A SMOOTH UNIFORM SURFACE FREE OF DEFECTS AND IRREGULARITIES. CASTING DATE SHALL BE SHOWN ON BARRIER. ALL EXPOSED EDGES OF CONCRETE SHALL BE CHAMFERED  $\frac{3}{4}$ ", UNLESS OTHERWISE NOTED.
- (2) ALL REINFORCING STEEL SHALL BE AASHTO M31 (ASTM A615) GRADE 60. ALL REINFORCEMENT SHALL HAVE  $1\frac{1}{2}$ " MINIMUM CLEAR COVER, UNLESS OTHERWISE NOTED.
- (3) STRUCTURAL STEEL, EXCEPT THE STEEL TUBES, SHALL BE ASTM A36 OR A572. ALL STEEL SHALL BE FABRICATED IN ACCORDANCE WITH SECTION 550.
- (4) STEEL TUBES,  $6" \times 6" \times \frac{3}{16}"$  &  $4" \times 4" \times \frac{1}{2}"$ , SHALL BE ASTM A 500 GRADE B OR C. ALL TUBES SHALL BE GALVANIZED IN ACCORDANCE WITH SECTION 550.
- (5) ALL STEEL FOR CONNECTION KEY AND TRANSITION KEY ASSEMBLIES SHALL BE GALVANIZED IN ACCORDANCE WITH SECTION 550.
- (6) A MINIMUM OF 2 LIFTING DEVICES, EACH WITH THE CAPACITY TO LIFT A MASS OF 6 TONS (MINIMUM), SHALL BE INSTALLED TO EACH BARRIER UNIT. TWENTY FOOT LONG CONCRETE BARRIER UNITS ARE APPROXIMATELY 400 LBS./FT.
- (7) DELINEATORS SHALL BE ATTACHED TO BARRIER USING AN APPROVED ADHESIVE MATERIAL OR AS SHOWN ON THIS SHEET.

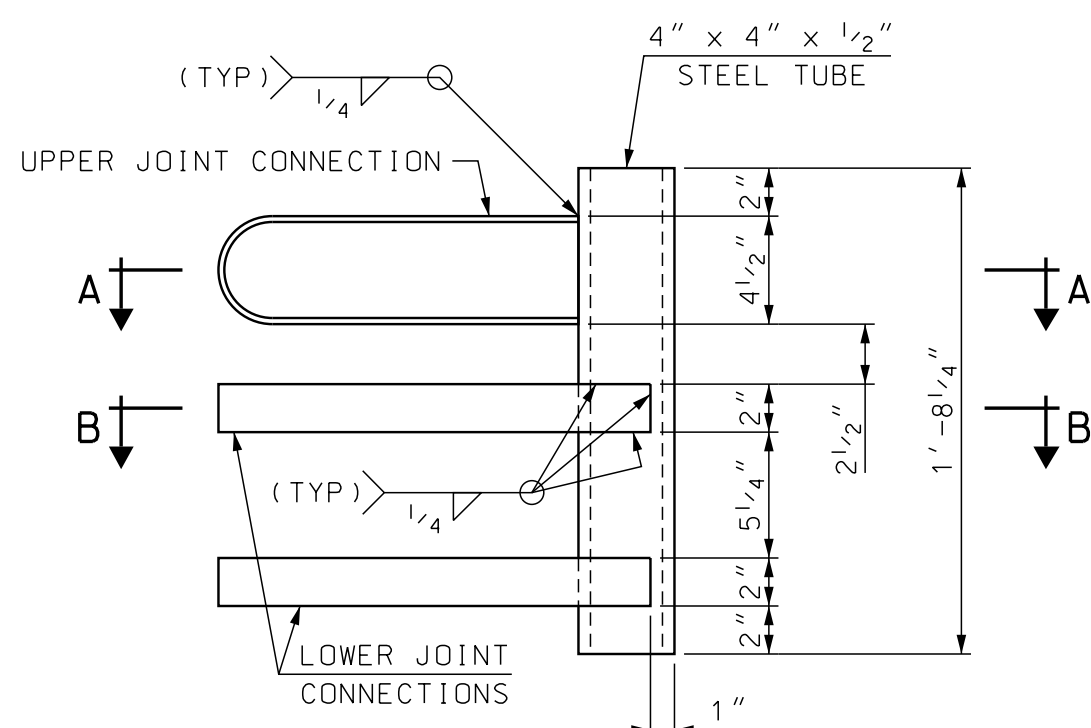


## END VIEW

SECTION C-C

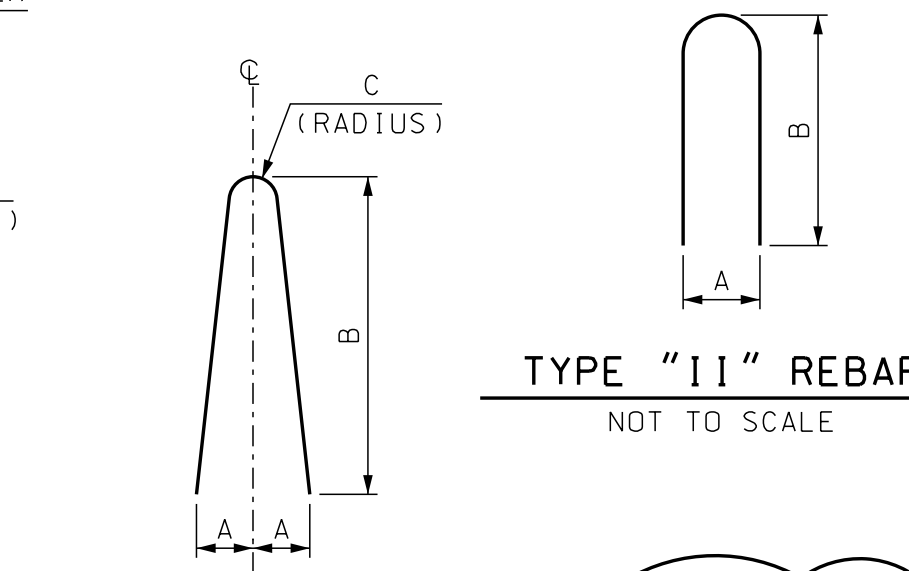
## CONNECTION KEY ASSEMBLY DETAILS

SCALE:  $1\frac{1}{2}'' = 1' - 0''$



JOINT ASSEMBLY

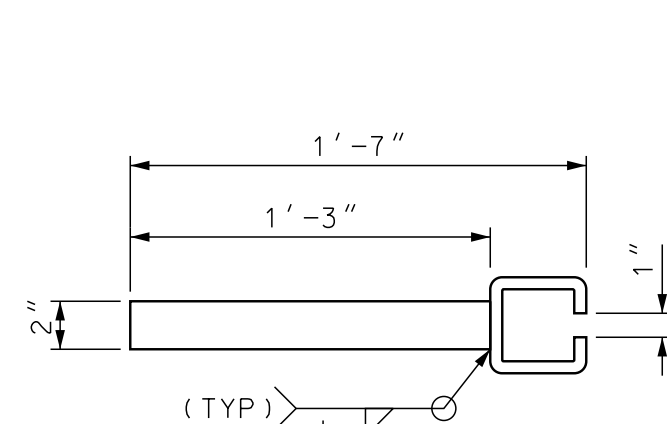
SCALE:  $1\frac{1}{2}'' = 1' - 0''$



TYPE "I" REBAR

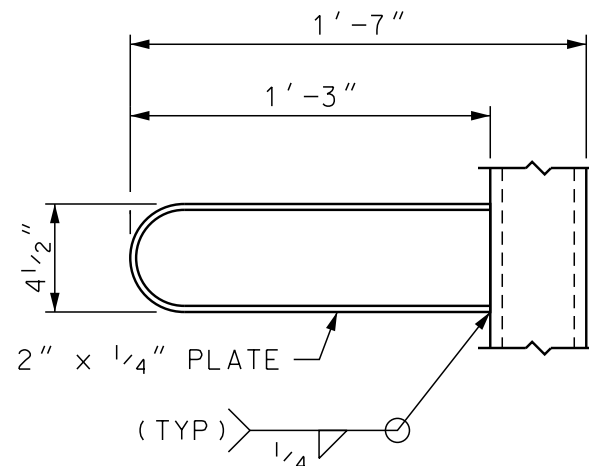
NOT TO SCALE

NO MODIFICATIONS  
SHOULD BE MADE TO  
THIS SHEET



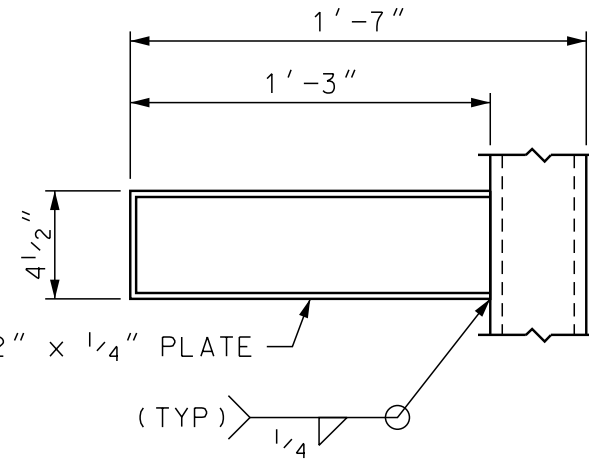
SECTION A-A

(UPPER CONNECTION)



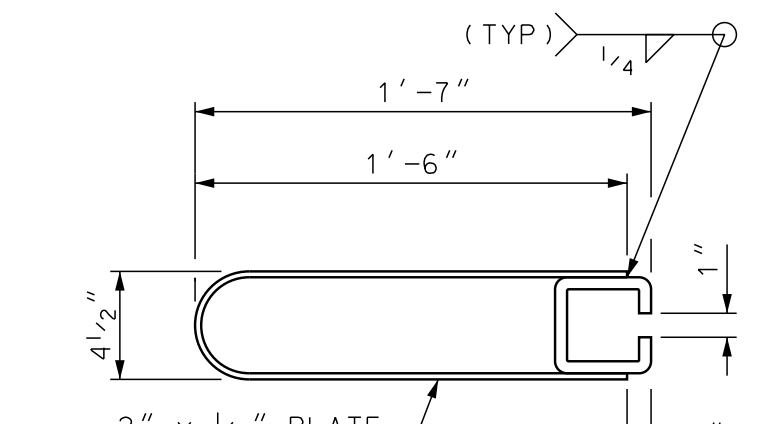
ELEVATION

(UPPER CONNECTION)



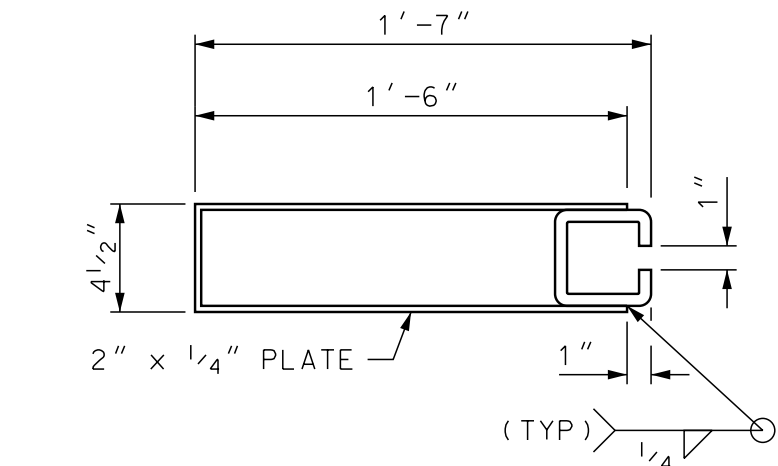
### ELEVATION

(UPPER CONNECTION - ALTERNATE)



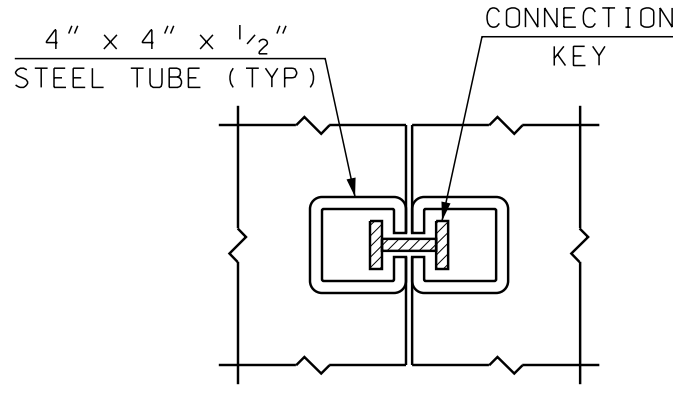
## SECTION B-E

(LOWER CONNECTION)



SECTION B-B

(LOWER CONNECTIONS - ALTERNA



### CONNECTION JOINT DETAIL

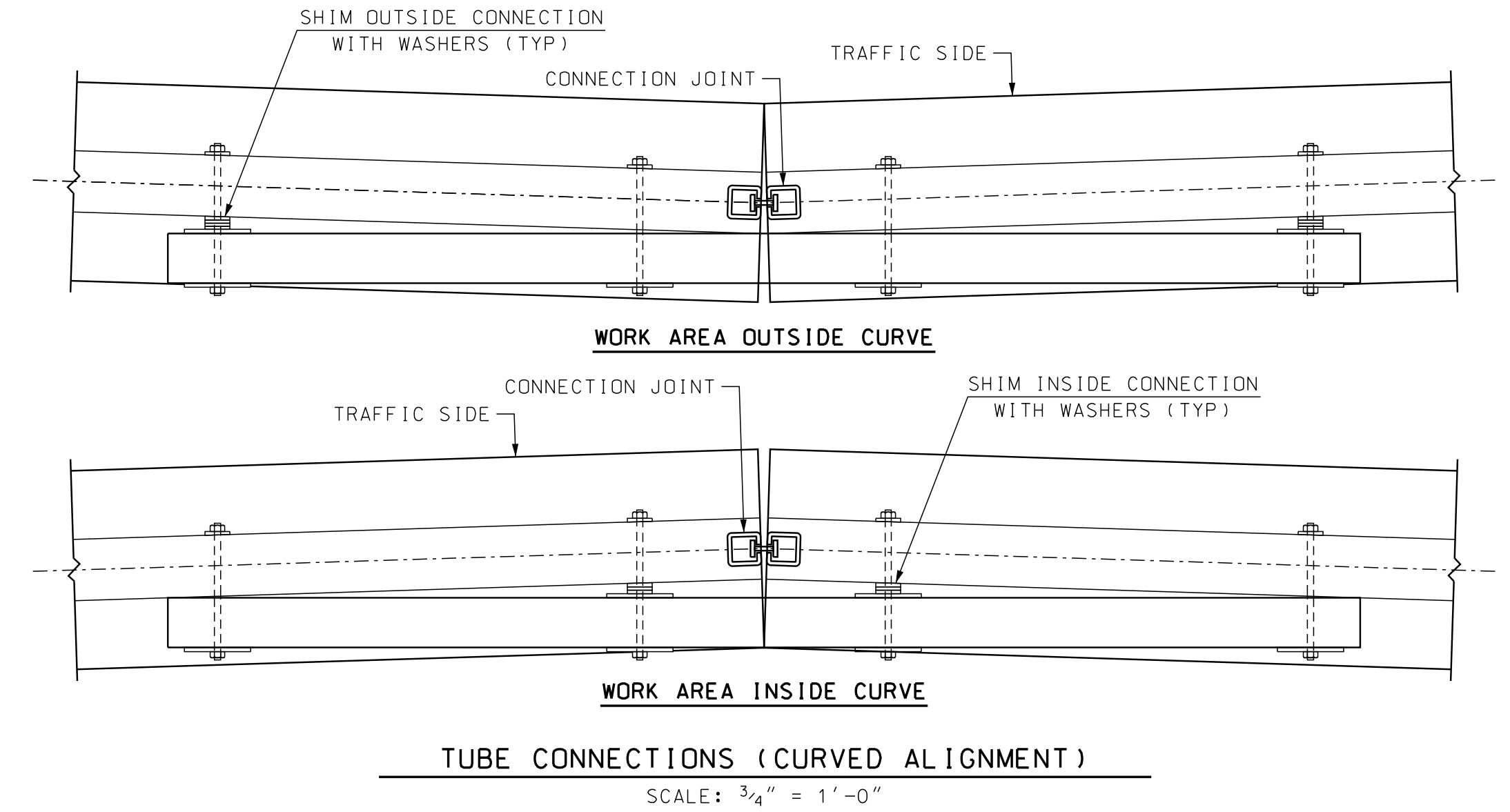
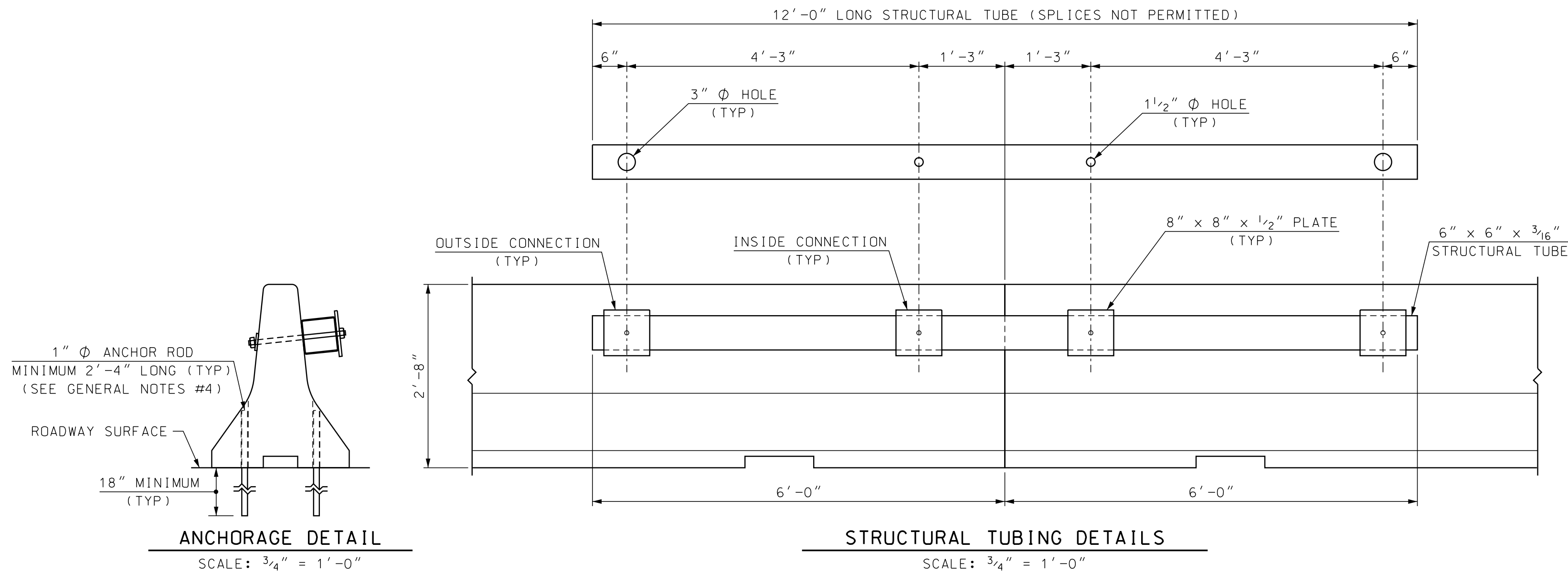
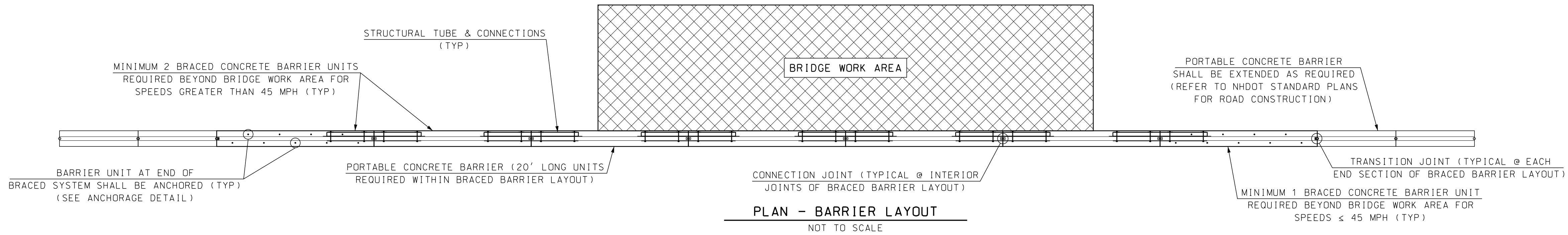
NOT TO SCALE

| REINFORCING SCHEDULE (PER 20' BARRIER UNIT) |      |        |          |      |    |       |    |                       |
|---|------|--------|----------|------|----|-------|----|-----------------------|
| MARK  | SIZE | LENGTH | # PIECES | TYPE | A  | B     | C  | LOCATION              |
| B1  | #4   | 4'-10" | 6        | I    | 5" | 2'-4" | 1" | STIRRUPS              |
| B2  | #6   | 19'-1" | 2        | ---  |    |       |    | LONGITUDINAL (TOP)    |
| B3  | #6   | 19'-9" | 2        | ---  |    |       |    | LONGITUDINAL (BOTTOM) |
| B4  | #6   | 1'-2"  | 2        | ---  |    |       |    | TRANSVERSE (BOTTOM)   |
| B5  | #6   | 6"     | 2        | ---  |    |       |    | TRANSVERSE (TOP)      |
| B6  | #4   | 2'-9"  | 9        | II   | 5" | 1'-3" |    | STIRRUPS              |

|                 |              |             |
|-----------------|--------------|-------------|
| SUBDIRECTORY    | .DGN LOCATOR | SHEET SCALE |
| English/BARRIER | PCB-BRACED   | AS NOTED    |

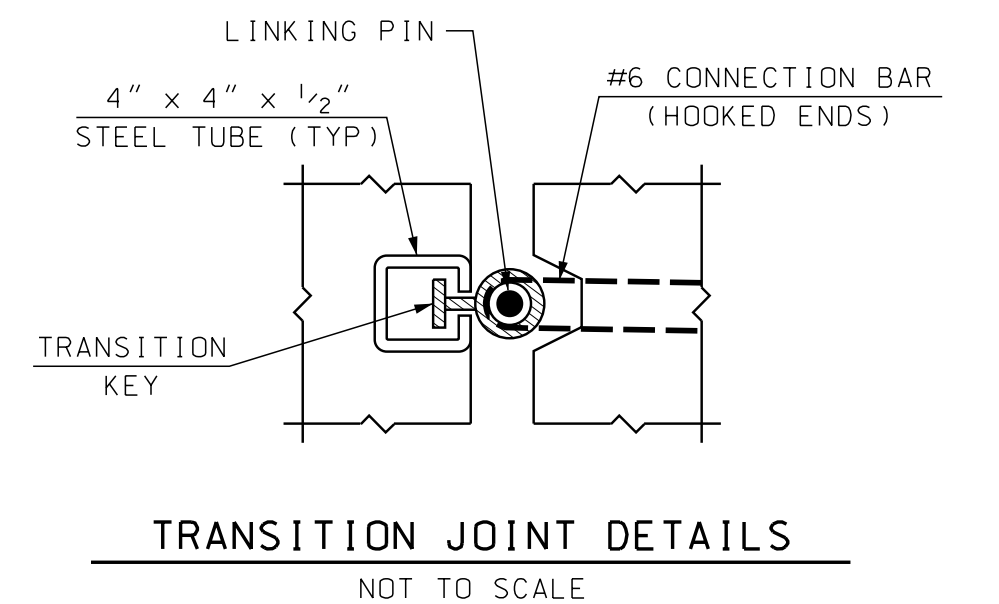
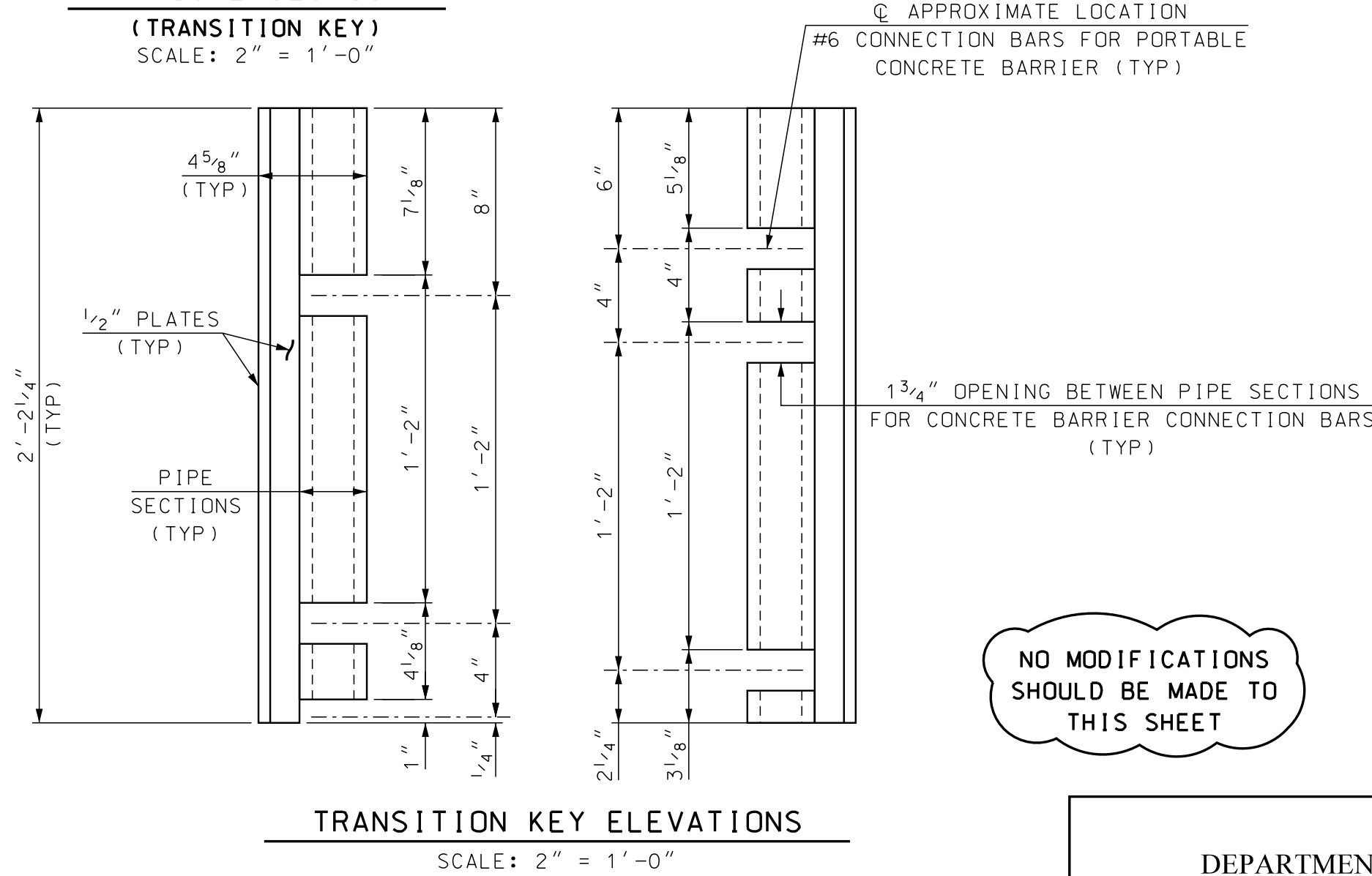
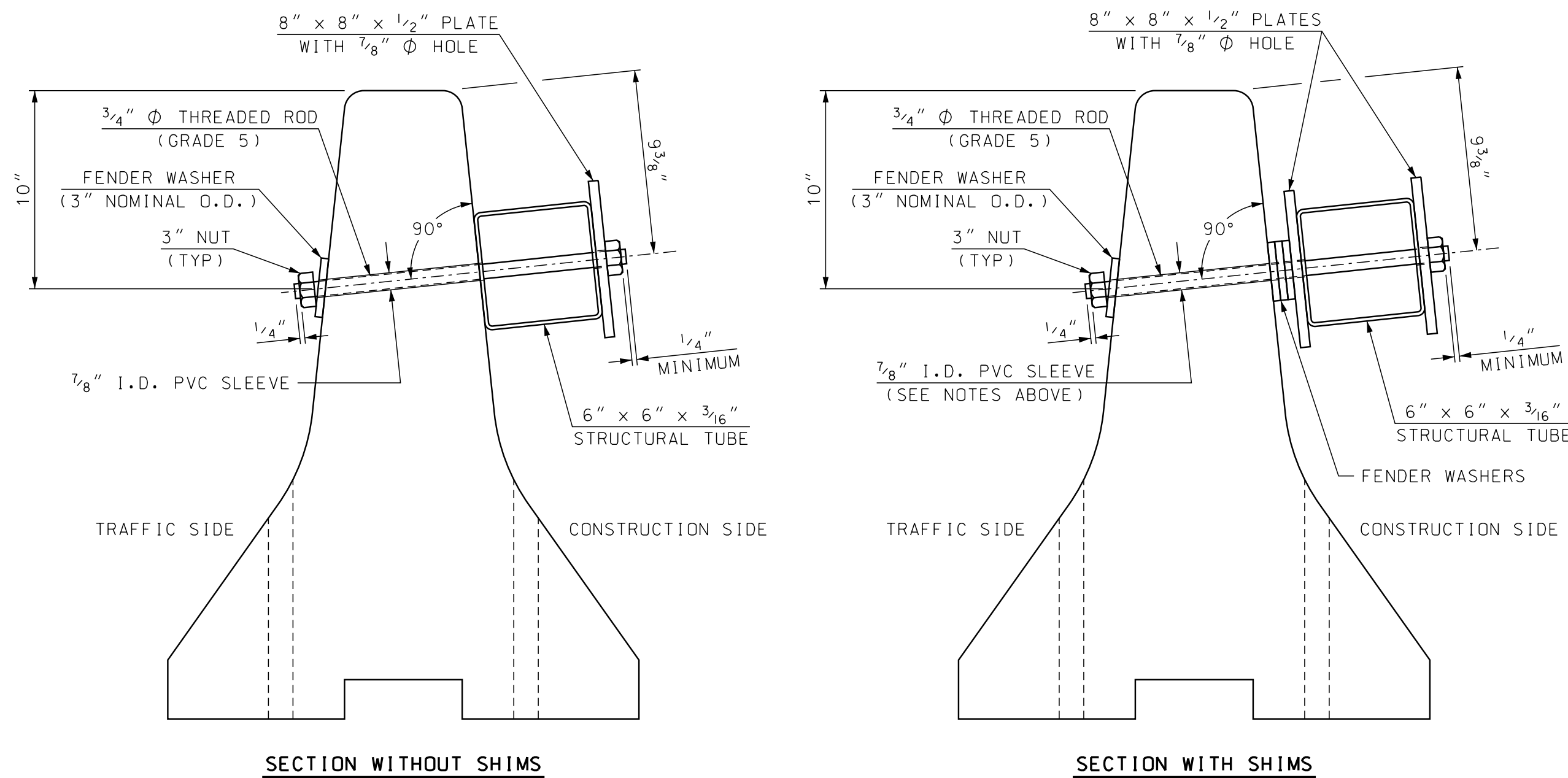
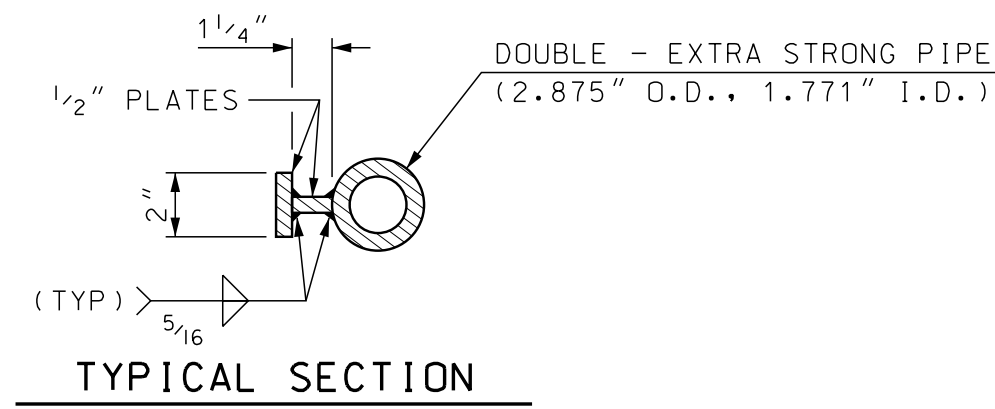
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|--|--|--|------------|------------|---------------------|---------|-----|---------------|-----------|--------------|--------------|
| STATE OF NEW HAMPSHIRE                                 |  |  |            |            |                     |         |     |               |           |              |              |
| DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN |  |  |            |            |                     |         |     |               |           |              |              |
| TOWN   |  |  |            | BRIDGE NO. |                     |         |     | STATE PROJECT |           |              |              |
| LOCATION   |  |  |            |            |                     |         |     |               |           |              |              |
| PORTABLE CONCRETE BARRIER - BRACED (1 OF 2)            |  |  |            |            |                     |         |     |               |           | BRIDGE SHEET |              |
| REVISIONS AFTER PROPOSAL                               |  |  | BY         |            | DATE                |         | BY  |               | DATE      |              | OF           |
|  |  |  | DESIGNED   | NHDOT      | 7/12                | CHECKED | ABH | 8/12          |           |              | FILE NUMBER  |
|  |  |  | DRAWN      | PJP        | 8/12                | CHECKED | ABH | 8/12          |           |              |              |
|  |  |  | QUANTITIES |            |                     | CHECKED |     |               |           |              |              |
|  |  |  | ISSUE DATE | 8/15/12    | FEDERAL PROJECT NO. |         |     |               | SHEET NO. |              | TOTAL SHEETS |
|  |  |  | REV. DATE  | 4/30/13    | -----               |         |     |               |           |              |              |





PVC SLEEVE OPENINGS SHALL BE MODIFIED/DRILLED AS REQUIRED TO PROPERLY ALIGN STRUCTURAL TUBE BRACING UNITS FOR CURVED ALIGNMENTS

THE PRESENCE OF NORMAL HOLES WHICH HAVE BEEN MODIFIED/DRILLED WILL NOT AFFECT THE REUSE OF CONCRETE BARRIER UNITS



NO MODIFICATIONS  
SHOULD BE MADE TO  
THIS SHEET

| STATE OF NEW HAMPSHIRE                                 |  |            |  |            |  |               |  |                     |  |              |  |
|--|--|------------|--|------------|--|---------------|--|---------------------|--|--------------|--|
| DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN |  |            |  |            |  |               |  |                     |  |              |  |
| TOWN   |  | BRIDGE NO. |  |            |  | STATE PROJECT |  |                     |  |              |  |
| LOCATION   |  |            |  |            |  |               |  |                     |  |              |  |
| PORTABLE CONCRETE BARRIER - BRACED (2 OF 2)            |  |            |  |            |  |               |  | BRIDGE SHEET        |  |              |  |
| REVISIONS AFTER PROPOSAL                               |  |            |  | BY         |  | DATE          |  | BY                  |  | DATE         |  |
|  |  |            |  | DESIGNED   |  | NHDOT         |  | 7/12                |  | CHECKED      |  |
|  |  |            |  | DRAWN      |  | PJP           |  | 8/12                |  | CHECKED      |  |
|  |  |            |  | QUANTITIES |  |               |  |                     |  | CHECKED      |  |
|  |  |            |  | ISSUE DATE |  | 8/15/12       |  | FEDERAL PROJECT NO. |  | SHEET NO.    |  |
|  |  |            |  | REV. DATE  |  | 4/30/13       |  | -----               |  |              |  |
|  |  |            |  |            |  |               |  |                     |  | TOTAL SHEETS |  |

|                 |             |             |
|-----------------|-------------|-------------|
| SUBDIRECTORY    | DGN LOCATOR | SHEET SCALE |
| English/BARRIER | PCB-BRACED  | AS NOTED    |