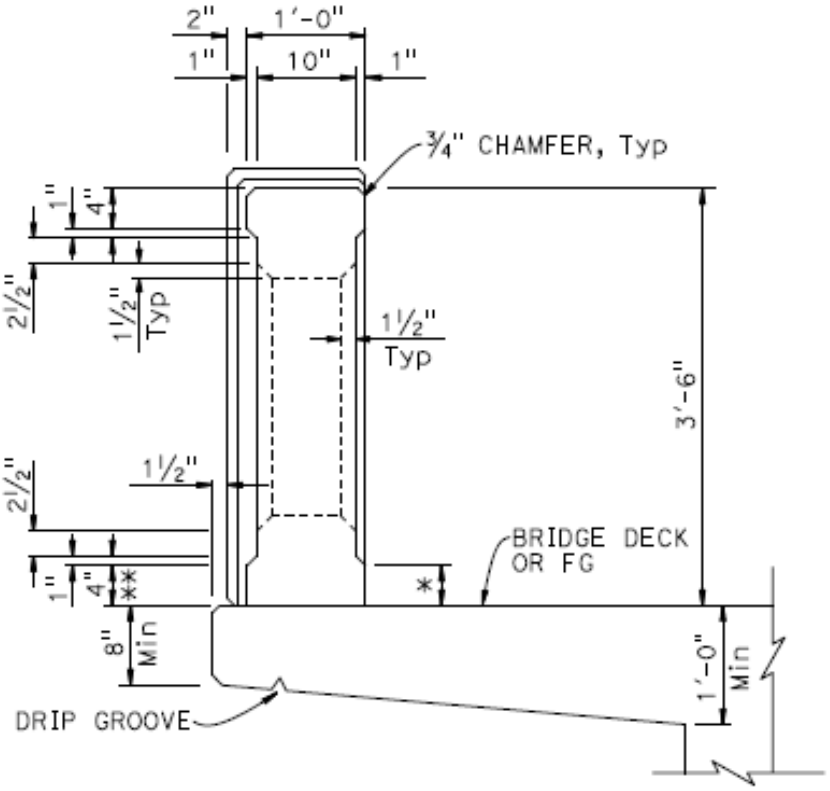
Section 16 – Barriers and Railings
Concrete Barrier Type 511H

XS Sheet Numbers

xs16-135-1, xs16-135-2, xs16-135-3, and xs16-135-4

Description of Component



Concrete Barrier Type 511H bridge railing (Type 511H)

New aesthetic Type 511H is required to comply with the National Historic Preservation Act and for use on projects that may require consultation with the State Historic Preservation Officer (SHPO) in the California Department of Parks and Recreation. Concrete Barrier Type 511H includes an aesthetic component between upper beam and lower beam (curb) composed of concrete balusters and clear openings between balusters that are visually compatible with the open concrete baluster rail seen on many historic bridges. The traffic face of the upper beam is 4 inches thick, in addition to 2 chamfers (total 5 inches thick) into the balusters and balusters' openings which makes the total depth of the upper beam at the balusters and the baluster opening locations 9 inches thick. The "H" in Type 511H stands for "Historic" because its most common use will be at locations where the existing structure has a historic designation, or the area is a historic district.

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Approved per MASH 2016 (AASHTO Manual for Assessing Safety Hardware) and approved for TL-2 low-speed locations only (regulatory speed limits of 45 mph or less). Concrete Post & Beam see-thru Combination Railing (vehicular and bicycle) is a post and beam style concrete barrier on concrete lower beam that is connected to reinforced concrete bridge deck, wingwall, or retaining wall as shown on the plans. It can be specially designed to connect to concrete barrier moment slab, structure approach slab, or top slab of concrete box culvert where the top slab acts as the vehicular riding surface.

Vehicular rail height is 3 feet – 6 inches above Finish Grade.

Overall barrier width is 1 foot – 2 inches and requires 1 ½” offset to Edge-Of-Deck (EOD), so the official barrier width is 1 foot - 3 ½ inches from EOD.

Balusters next to concrete posts can be more than 7 inches wide in the direction of traffic to accommodate any difference in span length, so there is no need to provide any clear openings less than the standard 6-inch width between balusters. In this case, additional vertical reinforcement may be required.

Concrete posts can be added as needed between expansion joints to match the aesthetic of an existing concrete baluster-style bridge rail that is being replaced.

Aesthetic see-through railing.

Standard Drawing Features

All four of the Bridge Standard Detail Sheets must be reviewed by the PDT and any historical committees representing the community for applicability, then pertinent details may be edited as needed for a specific project by the Engineer of Record (EOR) and included in the contract plans:

Sheet Number: xs16-135-1

Includes elevation and plan views for typical railing system with approach and departure concrete transition end blocks, a typical section, and concrete barrier reinforcement with typical transverse and longitudinal deck reinforcement.

Sheet Number: xs16-135-2

Includes railing system details on top of a wall or retaining wall and trench footing, a longitudinal section for reinforcement details.

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Sheet Number: xs16-135-3

Includes elevation view, upper beam & lower beam (curb) reinforcement, typical balusters reinforcement, reinforcement of balusters adjacent to expansion joints and end blocks, details for end block reinforcement and options of shapes of clear openings and baluster.

Sheet Number: xs16-135-4

Includes MASH compliant details for approach end block details and features the vertical slotted holes to aid with constructability of the thrie beam rail. Caltrans is adapting bridge approach end block per the crash tested and approved details developed by the Midwest Roadside Safety Facility (MwRSF) at the University of Nebraska (TRP 03-367-19-R1) for the MwRSF Pooled Fund of which Caltrans is a member State DOT.

The end of the approach end block tapers down in height to 35” above shoulder FG.

Design/General Notes

Design Criteria:

AASHTO LRFD Bridge Design Specifications 8th edition with California Amendments:

Live Loading

- HL 93 and permit design load

Vehicular Collision Force

- MASH 2016, Test Level 2

Concrete

- f_y = 60 ksi (ASTM A706/706M, Grade 60)
- f'_c = 4 ksi

Designers must ensure that any supporting structures, such as the bridge deck, wing wall, retaining wall or bridge deck overhang, meet the requirements in the AASHTO LRFD Bridge Design Specifications, Appendix in Section 13, Railing, as amended by Caltrans California Amendments (AASHTO-CA-BDS-8 – Section 13).

Supporting elements, such as the deck and overhang, must be designed to three applicable load cases:

- Case 1: Extreme Event II (transverse and longitudinal forces)
- Case 2: Extreme Event II (vertical forces)
- Case 3: Strength I

The clearance to reinforcement in the concrete upper beam and concrete lower beam (curb) is 2 inches. The clearance to reinforcement in the concrete transition end blocks at the approach and departure ends is 1 inch at the traffic face, the back face, and the top.

For projects located in a corrosive environment, refer to the AASHTO LRFD Bridge Design Specification Section 5.12 for using epoxy-coated rebar, Standard Specifications Section 52-2, and Structure Technical Policy 5.1 (STP 5.1) Corrosion Protection for Structural Concrete Elements. Designers may also use stainless steel reinforcement, per Standard Specifications, stainless steel reinforcement must comply with ASTM A955/A955M, Grade 60, UNS Designation S31653, S32304, S32205, or S31803.

Crashworthiness:

Caltrans is adapting Texas Department of Transportation (TxDOT) Type C411 Bridge Rail which was successfully crash tested by Texas Transportation Institute (TTI), see MASH crash test report by TTI Research Report No. 0-6946-R2

Type 511H (Caltrans version of TxDOT Type C411 Bridge Rail) was approved by the Caltrans Highway Safety Features New Product Committee (HSFNPC) for MASH 2016 compliance.

The report is available from the Caltrans Division of Research, Innovation and System Information (DRISI), Roadside Safety Research Group. More information regarding MASH Implementation by Caltrans can be found at the Caltrans/Division of Safety Programs Implementation of the Manual for Assessing Safety Hardware (MASH) webpage.

Utilities and Overlays:

No conduits are permitted in the concrete parapet or in the deck overhang directly below the concrete parapet. If a conduit is needed it either has to be attached to the backside at the base of the Type 511H (with concurrence from Caltrans Division of Maintenance/ Structure Maintenance and Investigations, and also Caltrans District Landscape Architecture). As an alternative, special design is required using a single 1 ½ -inch conduit placed in the deck overhang with a special design electrolier pedestal

and a special design concrete post at electrolier pedestal location (if needed). If conduit and or electrolier pedestal is desired, contact the Bridge Railing Technical Specialist.

If a deck overlay is being added to the bridge deck or approach slab or concrete barrier moment slab on the same contract that the concrete barrier is being constructed, then the concrete lower beam (curb) should be constructed to an additional height equal to the depth of the overlay so that, after the overlay is placed, the height of the concrete lower beam (curb) is 9 inches above the Finish Grade (FG) of the deck overlay instead of the concrete bridge deck, and the height of the vehicular railing parapet will measure 3 feet – 6 inches above the FG.

If a deck overlay is planned for an existing bridge deck with an existing Concrete Barrier Type 511H, then consider the following options:

- No deck overlay.
- Taper the deck overlay down to the minimum depth permissible and stop at least 3 feet – 0 inches away measured transversely from the traffic side toe of the lower beam (curb) of the Concrete Barrier Type 511H.
- If an overlay is needed to extend all the way to the lower beam (curb) face such as in a marine environment or in snow country where it is needed to seal the deck surface, then taper down the depth of the overlay starting at the Edge of Travelled Way down to the minimum depth that the type of overlay can be placed. Then at that point start to remove surface of the deck shoulder down to the equivalent of the minimum possible overlay depth (as thin as allowable, but not to exceed 1-inch) at the toe of the lower beam (curb) of the Concrete Barrier Type 511H so that that minimum depth of the overlay can be placed all the way to the toe without reducing the 3 feet – 6 inch height measured from the Finish Grade of the overlay. This will minimize the area of deck shoulder that needs some minimal depth of bridge deck surface removal. If this is not possible, then may have to replace the existing bridge railing in conjunction with an overlay placed all the way to the toe of the bridge railing.
- If the shoulder is narrow which leaves little or no distance to taper down the overlay depth, then choose an overlay material that can be applied in the thinnest possible depth section and only remove the minimum area and minimum depth of deck surface close to the toe of the Type 511H in order to preserve the 3 feet – 6 inch height of the existing Type 511H.

When the existing bridge condition does not permit removing a portion of the top of the bridge deck surface for any specified reason, then the overlay options are limited

to either no overlay, or no overlay within 3 feet – 0 inches from the toe of the bridge railing, or overlay all the way to the toe of the bridge railing in conjunction with a bridge railing replacement where the height of the bridge rail lower beam (curb) is increased by the equivalent height of the overlay but not to exceed 2 inches whereby the height of the combination bridge rail will be the standard 3 feet – 6 inches above the top of the overlay.

Additional Drawings Needed to Complete PS&E

If the Type 511H concrete transition end blocks for a project are going to connect to something other than the guardrail transition Standard Plans for either Thrie Beam Barrier guardrail or Midwest Guardrail System, then special designed detail drawings will be required.

If the bicycle railing is needed to be taller than 42-inch in height, then special designed detail drawings will be required and will be placed and connected to the backside of the concrete upper beam, the concrete upper beam may need to be modified to be thicker in depth in order to accommodate the bicycle railing connection. If a special design bicycle railing is desired, contact the Bridge Railing Technical Specialist.

Additional detail drawings will be required if there is going to be any architectural texture on the back side and/or traffic side of Type 511H. If architectural texture is desired, contact the Bridge Railing Technical Specialist.

Contract Specifications

Caltrans Standard Specifications: Section 51 Concrete Structures, Section 52 Reinforcement, Section 55 Steel Structures, Section 83 Railing and Barriers, and if a special design is done to add chain link railing to Type 511H (such as, if the bridge goes over railroad tracks or if bridge is in an urban area or where a large volume of pedestrian traffic is anticipated, or other factors that may determine the need for chain link railing) then also Section 83-1.021 Chain Link Railing.

Restrictions on Use of Standard Drawings

- A special design is required if Concrete Barrier Type 511H is mounted on an Earth Retaining System (ERS) such as soldier pile wall, tie-back wall, or soil nail wall. For MSE wall, which is one type of ERS, a Type 511H would have to be mounted on concrete barrier moment slab over the top of the MSE wall (see xs12-090, xs13-020-05, and xs13-020-6). Reinforcement connecting the Type

511H bridge rail to the barrier moment slab must extend down and hook under the bottom mat of the barrier moment slab reinforcement.

- Sound walls cannot be mounted on the Concrete Barrier Type 511H.
- A special design is required to mount a chain link railing to the Concrete Barrier Type 511H. Chain link railing should only be added to Type 511H for specific lengths where required over railroad tracks or where over or adjacent to locations with security concerns.
- A special design is required to determine if the Type 511H can be retrofitted by drill and bond onto an existing bridge deck, existing retaining wall, existing approach slab, top slab of existing concrete box culvert or existing barrier moment slab; or if this concrete barrier cannot be considered for placement onto an existing bridge (or other structure noted above) without removal and replacement of the existing bridge deck overhang (or portion of other structure noted above). The Concrete Barrier Type 511H cannot be retrofitted onto the top of an existing retaining wall unless the existing retaining wall was designed for the transfer of vehicular impact loading, and -if so- the top of the existing wall will need to be removed and replaced due to the need to incorporate the concrete lower beam (curb) reinforcement. If Concrete Barrier Type 511H is desired as a concrete barrier at the top of an existing retaining wall that was not designed for the transfer of vehicular impact loading, then either the Concrete Barrier Type 511H will have to be mounted on a concrete barrier moment slab that extends over the top of the existing retaining wall or be mounted on a structure approach slab that extends over the top of the existing retaining wall or wing wall.
- The clear openings for the combination vehicular/bicycle rail are in conformance with the size limits set forth in Section 13 of the AASHTO LRFD Bridge Design Specifications along with Section 13 of the California Amendments.

Special Considerations

Aesthetics:

Aesthetic see-through bridge railings such as the Concrete Barrier Type 511H are preferred by the California Coastal Commission for use within the Coastal Zone and may also be selected for any location where a Context Sensitive Solution is warranted.

Consideration regarding aesthetics:

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- The height above Finish Grade at completion of construction contract cannot be less than the heights shown on the Bridge Standard Detail Sheets for Concrete Barrier Type 511H.

- Clear opening sizes between concrete balusters and between bicycle railing members (If added by special design) must comply with AASHTO-CA BDS-8 Section 13.9 Bicycle Railings and Section 13.8 Pedestrian Railing. The Bridge Standard Detail sheet xs16-135-3 shows three standard shapes for the top of the clear openings (gable, squared, and arch). The designer must choose the shape to use for the top of the clear openings and show/ note it on the structure plans and delete the rest of the clear opening shape options, then also delete " NOTE: Only one shape option shall be used per structure."

- All railing components (if added by special design) require a galvanized coating, galvanized railing can be painted after galvanization. There are no restrictions on the choice of paint color for the steel elements, except that yellow cannot be used because the MUTCD reserves that color for the median striping (cannot have a yellow-colored bridge rail at outside edge of structure/roadway). Common choices are: the galvanized dull grey (unpainted), the galvanized chrome grey (unpainted), Natina Stain (rusty brown or mottled rusty brown) over the galvanized steel railing, or white, light blue, green, black, brown or Golden Gate orange paint over the galvanized steel railing.
- If a Context Sensitive Solution is desired for a bicycle railing (if desired to be added by special design), then a special design could be done for the bicycle railing itself. If so, the special design railing must comply with the design capacity and clear opening requirements shown in Section 13 RAILINGS of AASHTO-CA BDS-8. Type 511H can have color added by either staining the concrete surface or adding dye to the concrete mix, or both. When adding color to concrete barrier surface, stain should be used. Stain penetrates into the surface so if the concrete surface is lightly impacted the color will still remain, whereas paint is only adhered to the surface and will scrape off even if lightly impacted. Paint peels over time and more rapidly in harsh environments.
- Architectural texture can be added to the surface of concrete barriers, but the depth of texture must be added to the outside of the cross section of the standard details for the concrete barrier (so a textured barrier will be wider than the standard barrier and this may affect the bridge width). When texture is added to a concrete post-and-beam bridge rail, the minimum offsets from the upper beam

to the posts and from the lower beam (curb) to the posts must both be preserved on the traffic side. If texture is planned for the traffic side of a concrete post-and-beam bridge rail the lower beam (curb) portion of the rail can only have very little texture depth, and if it has any texture it needs to also be a smooth texture design so that tires will not climb the face of the rail. If architectural texture is desired, contact the Bridge Railing Technical Specialist.

Fixed objects, such as lighting standards or bridge-mounted signs, must be placed on a corbel or pedestal on the back side of a solid concrete post (that is not adjacent to expansion joint or end block) of the concrete post-and-beam style Type 511H. It's very likely that corbels supporting OH Signs mounted on a bridge will have to locate the corbel at a bent location. Corbels and pedestals will require a special designed detail. For special situations, contact both the Signs and Overhead Structures Technical Specialist and the Bridge Railing Technical Specialist in the Caltrans, Division of Engineering Services, Office of Design and Technical Services by email at DES Design and Technical Services.

All project-specific modifications to the Concrete Barrier Type 511H must be reviewed by the Bridge Railing Technical Specialist in the Caltrans, Division of Engineering Services, Office of Design and Technical Services. Contact the Bridge Railing Technical Specialist by email at DES Design and Technical Services.