



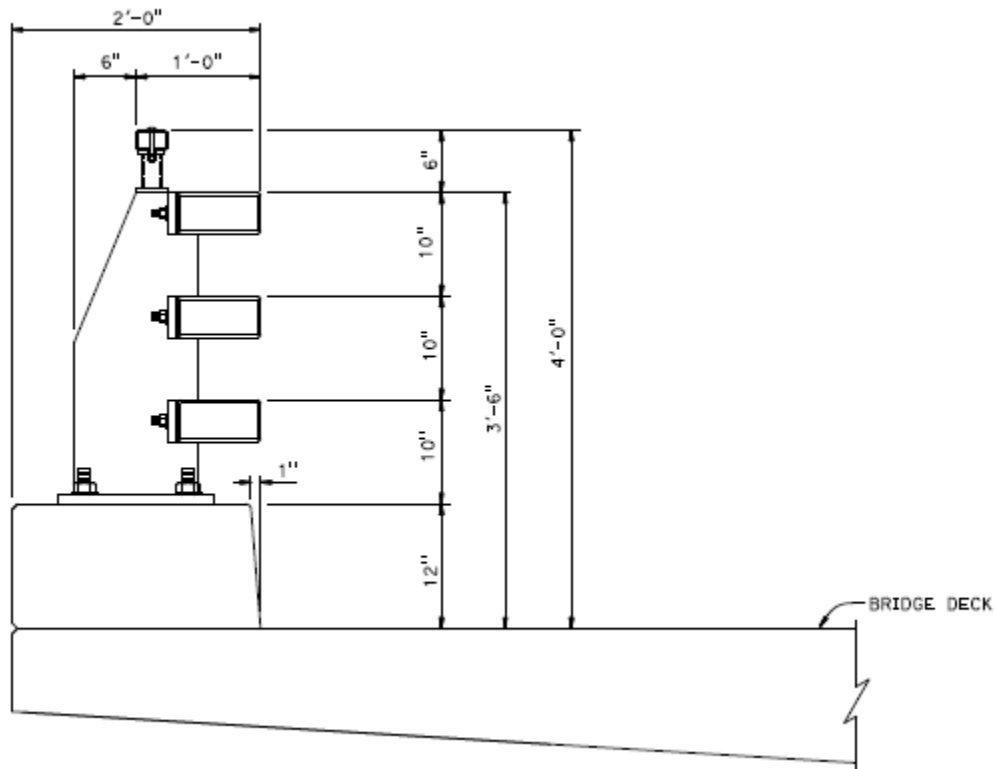
Caltrans® User Guide to Bridge Standard Detail Sheets

## Section 16 – Barriers and Railings California ST-76 Bridge Rail

### XS Sheet Numbers

xs16-121-1, xs16-121-2, xs16-121-3, xs16-121-4, and xs16-121-5

### Description of Component



### California ST-76 Bridge Rail

Replaces California ST-70 Bridge Rail and California ST-20S Bridge Rail.

Approved per MASH 2016 (AASHTO Manual for Assessing Safety Hardware)

3 Tube Combination Railing (vehicular/bicycle)

Approved to TL-4 high speed locations (speed limits greater than 45 mph) and can therefore also be used in TL-2 low speed locations (speed limits equal to or less than 45 mph).



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### California ST-76 Bridge Rail

Steel post and beam style bridge rail on concrete curb that is connected to bridge deck, wingwall, retaining wall, concrete barrier moment slab, structure approach slab, or special designed top slab of concrete box culvert where the top slab acts as the vehicular riding surface. This bridge rail is connected to the structure it is mounted on with reinforcing, anchor bolts, and anchor bars.

Vehicular rail height is 3 feet – 6 inches above the bridge deck or Finish Grade. Bicycle railing height is 4 feet – 0 inches above the bridge deck or Finish Grade. For access-controlled freeways and expressways where bicycle traffic is prohibited by signage on the on-ramps, the bicycle railing (includes Bar 3 x 3/8 x 8" and above) may be omitted. In some instances, the District or stakeholders may have other reasons to include the 48-inch height bicycle railing at locations where bicycle traffic is prohibited or where a 42-inch minimum bicycle railing height (the 42-inch vehicular railing height of the CA ST-76 provides the 42-inch minimum bicycle railing height) would otherwise be adequate.

Width is 2 feet – 0 inches.

Post spacing is 10 feet – 0 inches maximum.

Aesthetic see-through railing.

### Standard Drawing Features

All five of the Bridge Standard Detail Sheets must be included in the contract plans:

Sheet Number: xs16-121-1

Includes typical rail system, anchor plates, base plate, shim plate details, and additional transverse deck rebar needed at post locations.

Sheet Number: xs16-121-2

Includes steel post and end block side view and Plan view. Elevation view of steel rail on concrete curb with approach and departure concrete transition end blocks. And rail end cap details.

Sheet Number: xs16-121-3

Includes steel post elevation view and side view, and bicycle railing connection details.

Sheet Number: xs16-121-4



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Includes details for standard sleeves and expansion sleeves, and Elevation view of standard splices and expansion splices and open joint in curb for the bridge rail.

Sheet Number: xs16-121-5

Indicates elevation view of parapet shoe and other sections and views that explain parapet shoe details. Isometric view of parapet shoe is also indicated. The parapet shoe is the welded steel assembly that provides a tapered surface between the clear openings of the steel bridge rail where the HSS steel rail tubes meet the concrete end blocks. The parapet shoe ensures that any portion of an impacting vehicle that has crushed into the clear openings will be smoothly redirected back out to the traffic face of the bridge rail/concrete end block.

#### 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 Test Level 4

Concrete

- $f_y = 60$  ksi (ASTM A706/706M, Grade 60)
- $f'_c = 3.6$  ksi
- $N = 8$

Structural Steel

- Posts & Plates:  $f_y = 36$  ksi min. (ASTM A709/A709M, Grade 36)
- Rails (HSS tubes):  $f_y = 46$  ksi (ASTM A500/A500M Grade B)
- Anchor Bolts: ASTM 1554, Grade 105
- Parapet shoe plates:  $f_y = 50$  ksi (ASTM A709/A709M, Grade 50)
- Structural steel bridge rail elements, anchor bolts, and associated hardware must be galvanized per Standard Specifications 75-1.02B Galvanizing.

Designers must ensure that any supporting structures, such as the deck or overhang, meet the requirements in the AASHTO LRFD Bridge Design Specifications, Appendix in Section 13, Railings, as amended by Caltrans California Amendments.



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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 curb is 2 inches at the traffic face and back face, and 1 inch on the top. 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 5.10 for using epoxy coated rebar and Standard Specifications 2018 section 52-2.

California ST-76 Bridge Rail was designed and checked as a new MASH-compliant bridge rail design including Finite Element Analysis.

#### **Crashworthiness:**

Crashworthiness of California ST-76 Bridge Rail was based on the successful MASH crash testing of the California ST-75 Bridge Rail. Refer to the following site for Vehicular Crash Tests of the [California ST-75 Bridge Rail Research Results](#). The Final Crash Test Report for the California ST-75 Bridge Rail and other general information will be posted to the Division of Research and Innovation and Systems Information webpage for [Research Final Reports in the Geotechnical and Structures subsection](#) pending final ADA remediation and publication. 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 Future Overlays:**

No conduits are permitted in the 12-inch height concrete curb or in the deck overhang below the concrete curb.

If an overlay is being added to the bridge deck or approach slab on the same contract that the bridge rail is being constructed, then the concrete curb should be constructed to an additional height equal to the depth of the overlay (not to exceed 2 inches in additional curb height) so that, after the overlay is placed, the height of the concrete curb is 12 inches above the Finish Grade of the overlay, and the height of the vehicular



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rail will still measure 3 feet – 6 inches above the Finish Grade which in this case is measured from the top of the overlay instead of the concrete bridge deck. It's important to note that the anchor bolts will need to be lengthened in this case by an amount equivalent to the depth of the overlay placed against the curb face of the ST-76 bridge rail.

If an overlay is planned for an existing bridge deck with an existing California ST-76 Bridge Rail, then consider the following options:

- No overlay.
- Taper the overlay down to zero or to its minimum depth and stop at least 3 feet – 0 inches away measured transversely from the traffic side toe of the concrete curb of the bridge rail.
- If need overlay to extend all the way to the 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 at the toe of the curb of the ST-76 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 of the bridge rail measured from the Finish Grade of the overlay (this will minimize the area of deck shoulder that needs some surface removal). If this is not possible, then may have to replace the existing bridge rail in conjunction with an overlay placed all the way to the toe of the bridge rail. Note that if a policy or 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 rail, or overlay all the way to the toe of the bridge rail in conjunction with a bridge rail replacement.
- 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 bridge rail in order to preserve the 3 feet – 6 inch height of the existing CA ST-76 vehicular rail and the 4 feet – 0 inch height of the bicycle railing.



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#### Additional Drawings Needed to Complete PS&E

Connection of CA ST-76 bridge rail concrete transition end block to guardrail transitions at approach and departure ends: Standard Plans A78F1 & A78F2 for Thrie Beam Barrier guardrail or Standard Plans A77U1 & A77U2 for Midwest Guardrail System (MGS).

If the bridge rail 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.

#### Contract Specifications

Caltrans Standard Specifications: Section 51 Concrete Structures, Section 52 Reinforcement, Section 55 Steel Structures, Section 59 Structural Steel Coatings, Section 75 Miscellaneous Metal, Section 83 Railings and Barriers, and Section 91 Paint, and if a special design is done to add chain link railing to the ST-76 (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 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 CA ST-76 is mounted on an earth retaining system.
- Sound walls cannot be mounted on the CA ST-76.
- A special design is required to mount a chain link railing to the CA ST-76.
- A special design is required for retrofitting this bridge rail onto an existing bridge deck, existing retaining wall, or existing barrier moment slab. Due to the need for the anchor bolts and anchor plates as well as the additional transverse deck bars at each post location, this bridge rail cannot be considered for placement onto an existing bridge without removal and replacement of the existing bridge deck overhang/barrier moment slab. The additional transverse bridge deck bars at the post locations cannot reach the required minimum 2 feet – 0 inches inward from



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the exterior girder with a deck overhang removal and replacement, so near surface deck strengthening should be considered if the CA ST-76 is desired to be added to an existing bridge. The CA ST-76 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 for the anchor bolts and anchor plates. If CA ST-76 is desired as a bridge rail at the top of an existing retaining wall that was not designed for the transfer of vehicular impact loading, then either the CA ST-76 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.

- This bridge rail is based on the successful crash testing of the CA ST-75 which was crash tested with the bicycle railing attached (offset 9 inches from the top of the traffic-side of the vehicular rail), and it passed, so per CA Amendment to AASHTO LRFD Bridge Design Specifications Section 13.9.2 Bicycle Railings, Geometry, the bicycle railing is acceptable without being offset by 15 inches from the top of the traffic-side of the vehicular rail.
- The clear openings for the vehicular rail and for the bicycle railing 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.



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#### Special Considerations

Should use a 42-inch vehicular rail height such as the CA ST-76 in these instances:

- On the high side of a bridge deck (or high side of a roadway where bridge rail at the outside edge is mounted on a retaining wall or concrete barrier moment slab or trench footing) when super-elevation is 6% or greater.
- Where end of bridge rail transitions to meet up with Type 60M (42-inch height) along outside edge of roadway.
- Where end of CA ST-76 on bridge/wingwall/structure approach slab/retaining wall meets up with CA ST-76B (CA ST-76 on trench footing) beyond end of structure.
- Whenever designer or stakeholders desire a 42-inch height vehicular bridge rail, for any reason, instead of any shorter bridge rail (36 inches is the minimum height required for MASH TL-4 bridge rails).
- Whenever designer or stakeholders desire a vehicular combination bridge rail that already meets the minimum bicycle/pedestrian railing height of 42 inches without a separate bicycle railing added to the top of the vehicular bridge rail.
- If one side of the bridge has a CA ST-76SW, then the opposite side (if opposite side of bridge does not have a sidewalk) should either have a CA ST-76 or a CA ST-75 to match the aesthetics.
- If the existing bridge has a 42-inch or greater height see-through aesthetic bridge rail, and the new project is either replacing the bridge rail or replacing the bridge, and -to address any context sensitive issues- it is desired to replace the bridge rail with a 42-inch vehicular rail height see-through aesthetic bridge rail that meets current standards ... then the see-through aesthetic CA ST-76 would be a good option.

Issues to consider to be able to determine when a taller-than-minimum bicycle railing should be used (in most cases, consider taller-than-minimum height when more than one of these cases exist, but if a single case is at the more extreme end, then only need that one case to justify taller-than-minimum):

- Bridge/highway located on small radius curve (where small radius is relative to the posted regulatory speed limit)
- High super-elevation of bridge/highway (6% or more)
- Narrower-than-standard shoulders





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- Sustained profile grade of 3% or more (for 300 feet or more, that includes the approach up to the bridge)
- Located where daytime visibility is frequently obscured (due to fog, dust/sandstorms, etc.)
- Located at bottom of T-intersections (if have downhill grade of 3% or more into a T-intersection with a bridge rail/bicycle rail at opposite side of T-intersection, then the bicycle railing height should 54 inches)
- If project stakeholders and Caltrans District or local agency have agreed on a taller-than-minimum bicycle railing height for any reason (this is not uncommon)

#### Aesthetics:

Aesthetic see-through bridge railings such as the CA ST-76 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.

#### In regards to aesthetics:

- All the steel railing components require a galvanized coating. There are no restrictions on choice of coating 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 but coated with copper sulfate solution), 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 the bicycle railing, 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 the AASHTO LRFD Bridge Design Specifications with California Amendments.
- Aesthetic metal bar design can be added in between the steel tubes if a custom artistic design is desired. This could be done to match a design of a custom pedestrian or bicycle railing on the bridge or to match or complement some feature on or near the bridge. If this is desired, it must be attached behind the traffic-side of the steel posts.
- Concrete curb of the CA ST-76 bridge railing can have color added by either staining the concrete surface or adding dye to the concrete mix, or both. When



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adding color to concrete barrier surface, stain should be used. Stain penetrates 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 curb of the CA ST-76, 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). If texture is planned for the traffic side of a steel post-and-beam bridge rail the lower concrete 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.

The height above Finish Grade for bridge railing at completion of construction contract cannot be less than the heights shown on the Bridge Standard Details sheets for CA ST-76.

Fixed objects, such as lighting standards or bridge-mounted signs, must be placed on a corbel or pedestal on an outcropped portion of the deck overhang on the back side of the steel bridge rail that 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](#). If scuppers are desired/needed then contact the Bridge Railing Technical Specialist by email at [DES Design and Technical Services](#). Also note that deck drainage can only be allowed to drop off the edge of deck by means of scuppers or down-drains if the Environmental Document allows it, and if there is no vehicular lanes/railroad tracks/bicycle path/walkway/or boating waterway directly below. All project-specific modifications to the CA ST-76 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](#).