User Guide to Bridge Standard Detail Sheets Section 15
– Soundwalls

XS Sheet Numbers
Masonry Block Sound Wall on Retaining Wall, XS15-120-1 & XS15-120-2
Masonry Block Sound Wall with Barrier on Retaining Wall, XS15-130-1 & XS15-130-2
Masonry Block Sound Wall with Barrier on Bridge, XS15-140-1 & XS15-140-2

Description of Component
Masonry Soundwall details for applications not covered by Standard Plans. Note that previous Sound Wall Bridge Standard Detail sheets (XS) were designed to meet an older Uniform Building Code Standard from 1997.


Standard Drawing Features
Plans come in sets of two sheets per application. Applications are as described in the title block of each plan set, Details No. 1 and Details No. 2.

Details No. 1 sheet includes: General Notes, Design Notes, Elevations, Wall Section Views, and possibly a Typical Section.

Details No. 2 sheet includes: additional Typical Sections and additional details.

Design/General Notes

Wind Loads
Wind loads shall be applied per AASHTO LRFD Bridge Design Specifications 8th Edition (AASHTO) Section 15.8.2. Design wind pressures shall be determined using Section 3 of LRFD.

The following criteria from AASHTO shall be used when designing sound walls:

\[ V = \begin{align*} 110 \text{ mph} & \text{ for strength III load case} \\ 80 \text{ mph} & \text{ for strength V load case} \\ 70 \text{ mph} & \text{ for service I load case} \end{align*} \]

\[ G = 0.85 \]

\[ C_D = 1.2 \]

\[ P_Z = 2.56 \times 10^{-6} V^2 K_Z G C_D \]  
(AASHTO 3.8.1.2.1-1)
Where:
PZ = Design wind pressure
V = Design 3-second gust wind speed
G = Gust effect factor
CD = Drag coefficient

The pressure exposure and elevation coefficient (KZ) shall be determined based on the site ground surface roughness, wind exposure category, and structure height (Z).

For Sound Wall Bridge Standard Details sheets, the following values were used:
For all except on bridge:

Wind exposure category = D
Z = 33 feet
PZ = 36.5 pounds per square feet for strength III load case
PZ = 19.3 pounds per square feet for strength V load case
PZ = 14.8 pounds per square feet for service I load case

On bridge:

Wind exposure category = D
Z = 60 feet
PZ = 40.7 pounds per square feet for strength III load case
PZ = 16.3 pounds per square feet for service I load case

The Sound Wall Bridge Standard Detail Sheets designs may be used in all locations where the site-determined design wind pressures (PZ) are equal to or less than those shown above.

For special wind regions as shown in AASHTO Figure 3.8.1.1.2-1, the previously listed design wind pressure (PZ) values shall not apply. The designer must determine the site-specific wind pressure (PZ) and modify the design.

**Seismic Loads**

The following values shall be used when designing sound wall:

0.57g, except on bridges
2.0g, on bridges
Horizontal seismic soil acceleration coefficient, kh = 0.25
Load Combinations

A summary of the relevant load combinations and load factors is provided in the following table:

<table>
<thead>
<tr>
<th></th>
<th>DC&lt;sub&gt;max&lt;/sub&gt;</th>
<th>DC&lt;sub&gt;min&lt;/sub&gt;</th>
<th>EH&lt;sub&gt;max&lt;/sub&gt;</th>
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<th>WS</th>
<th>EQ</th>
<th>CT</th>
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<tbody>
<tr>
<td>Service I</td>
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<td>-</td>
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<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>1.5</td>
<td>0.9</td>
<td>1.35</td>
<td>1.0</td>
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<td>-</td>
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<tr>
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<td>1.0</td>
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<td>-</td>
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<td>-</td>
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<tr>
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<td>-</td>
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</table>

Where:
- DC = Dead load of structural components
- EH = Horizontal earth pressure load
- LS = Live load surcharge
- WS = Wind load on structure
- EQ = Earthquake load
- CT = Vehicular collision force

Resistance factors are listed in the tables below:

**Reinforced Concrete (per AASHTO)**

<table>
<thead>
<tr>
<th></th>
<th>Strength Limit State</th>
<th>Extreme Limit State</th>
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<tbody>
<tr>
<td>For Flexure</td>
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<td>1.0</td>
</tr>
<tr>
<td>For Shear</td>
<td>0.9</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Concrete Masonry Units (per TMS)**

<table>
<thead>
<tr>
<th></th>
<th>Strength Limit State</th>
<th>Extreme Limit State</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Flexure</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>For Shear</td>
<td>0.8</td>
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</tbody>
</table>

**General Design & Material Notes**

1. Sound walls must be comprised of concrete masonry blocks. Minimum f’m = 2000 pounds per square inches. Minimum nominal block width = 8 inches.
2. The strength-reduction factors must be used as specified in Chapter 9 of The Masonry Society (TMS). Maximum sound wall height shall be 16 feet 4 inches.
3. Reinforced concrete masonry wall design must be per TMS strength design method. Design for wall in-plane loads is not required. Design must also satisfy the requirements of the CBC.
4. Horizontal reinforcement must meet the minimum TMS requirements for intermediate reinforced masonry shear walls. Bond beams are required at all horizontal reinforcement locations. Spacing must not exceed 48 inches.
5. Vertical reinforcement must be placed in pairs. Single centered reinforcing arrangements are not permitted.
6. Maximum spacing of vertical reinforcement must be 16 inches.
7. Minimum bar size, for vertical and horizontal wall reinforcement, must be #4. Reinforcing steel for sound walls on concrete barrier must comply with ASTM A706. Minimum yield strength (Fy) for all reinforcing steel must be 60 kips per square inches.
8. Wall expansion joints are required at 96 ft max on centers for barriers and on retaining wall or wherever there is an expansion joint in the bridge or barrier. Minimum length of any wall section must be 24 feet.

9. When masonry units are laid in stacked bond, ladder type, galvanized joint reinforcement must be required. The joint reinforcement must not be less than two continuous W9 wires at 48 inches maximum. This reinforcement is to be embedded in the mortar bed joints at 24 inches maximum between bond beams. Yield line analysis may be used for the vehicular collision load ultimate resistance calculations, per AASHTO A13.3.1.

Masonry Block Sound Wall on Retaining Wall

XS15-120-1, XS15-120-2

Walls placed directly on retaining wall are permissible only when the wall is located outside the clear recovery zone (CRZ) as defined in the Highway Design Manual.

Masonry Block Sound Wall with Barrier on Retaining Wall

XS15-130-1, XS15-130-2

Whenever sound wall is placed on top of concrete barrier on retaining wall, adequacy of the sound wall must be verified by a TL-4 crash test as defined in Manual for Assessing Safety Hardware (MASH) or must be designed to resist the vehicular collision loads Criteria shown below in Figure 1 (refer to AASHTO sections A13.2 and 15.8.4 for Ft values and further detail).

The yield line analysis and strength design method, as outlined in AASHTO A13.3.1, must be used for the design of fully grouted masonry block sound wall and concrete barrier. Total capacity of the sound wall, $R_w$, must meet or exceed the TL level selected for design. Please note that $M_c$ is not required to independently resist the full applied loading without contribution from $M_w$. Shear resistance at the interface of the wall and barrier must be evaluated per the shear friction method of ACI 318. For the shear demand at this interface, it shall be assumed that the load is uniform distributed across $L_c$ as calculated in AASHTO A13.3.1. Refer to AASHTO A13.3.1 for explanation of $F_t$, $R_w$, $M_c$, $M_w$ and $L_c$.

Where retaining walls (including standard retaining wall types 1, 1A, 2, 3, 4 or 5) are used to support Sound Walls on Concrete Barriers, the wall and foundation must be investigated for the full sound wall loading. This shall include the vehicular collision loads applied directly to the concrete barrier and to the sound wall (non-concurrent).

Additional Drawings Needed to Complete PS&E

For details not shown, see RSP B11-81 & RSP B11-82. Dimensions may vary with roadway cross slope and with certain thicknesses of surfacing, See Roadway Plans. For
electrolier mounting details, see RSP B11-81, RSP B11-82, ES-6A and ES-6B. If Chain Link Railing (CLR) is required or desired, it will be permissible to be attached to Concrete Barrier Type 836/842 Retrofit per Standard Plan B11-7.

Connection of concrete transition end block to guardrail transitions at approach and departure ends: Standard Plans A78F1 & A78F2 for Thrie Beam Barrier 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 details will be required.

Contract Specifications
Caltrans Standard Specifications: Section 51 Concrete Structures, Section 52 Reinforcement, Section 56 Overhead Sign Structures, Standards, and Poles, 58 Sound Walls, Section 75 Miscellaneous Metal, Section 83 Railings and Barriers, and Section 59 Painting.

Restrictions on Use of Standard Drawings
Site-specific seismic determinations are required for walls higher than 16 feet on retaining walls or higher than 16 feet and 2 inches on barriers on retaining walls or on bridges or when seismic acceleration is higher than as noted above. Seismic design methodology for ground-supported walls given in ASCE 7-16 must be used.

Designers must ensure that any supporting structures, such as the bridge deck overhang or retaining wall meet the requirements in the AASHTO LRFD Bridge Design Specifications and Section 13, Railings, and Appendix A13 and as amended by Caltrans’ California Amendments.

Sound wall cannot be mounted on Concrete Barrier Type 836/842 Retrofit.

Special Considerations
Retrofitting barriers with sound walls may require replacing the entire barrier due to either its inadequate flexural capacity to carry the wall loads, or because of inadequate anchorage of the barrier to the deck. Bridge overhangs must be checked for structural adequacy. Check as-built plans for material capacities of the existing structure. Steel girder bridges may require strengthening. Do not place masonry block walls on existing steel girder bridges when traffic is carried on the structure during masonry construction. Traffic vibration will cause settlement of blocks into the mortar bed.

The addition of sound walls to existing bridges may cause changes in the structure deflections that could result in drainage problems along the deck surface. Existing
profiles, cross slopes, and deflections must be checked to ensure adequate drainage when sound walls are placed on structures with flat grades.

Sound walls on approach slabs require special consideration. Standard Plan approach slabs are not designed to accommodate the wall dead load and lateral loads transferred from it. Also, approach slab settlement and deflection may cause structural and alignment problems. Isolation of these loads are required and will require a special design. Contact the Approach Slab Specialist for recommendations.

Future overlays:

The height above Finish Grade for bridge railing at completion of construction contract cannot be less than the heights shown on the Revised Standard Plan sheets for Concrete Barrier Type 842. For example: 42 inches height above concrete deck or above Finish Grade with no overlay, or 42 inches height above the Finish Grade of a polyester concrete overlay.

All project-specific modifications to the above-mentioned Bridge Standard Details Sheets, must be reviewed by the Sound Wall Technical Specialist in the Caltrans/Division of Engineering Services/Office of Design and Technical Services. Please contact the Office of Design and Technical Services.