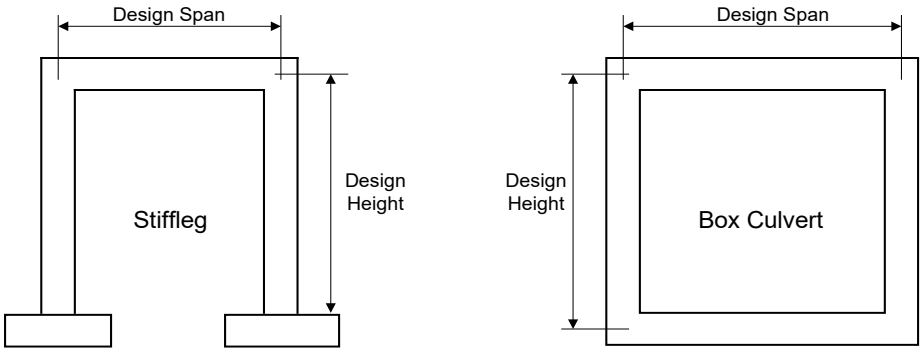
DESIGN GUIDELINES FOR PRECAST & CAST-IN-PLACE STIFFLEGS AND BOX CULVERTS

The design of concrete cast-in-place and precast culverts shall be in accordance with the AASHTO LRFD Bridge Design Specifications, Chapter 12, except for the ITD policy noted below.



GENERAL

The following apply to both cast-in-place and precast culverts.

DISTANCE BETWEEN FINISHED GRADE & TOP OF DECK BETWEEN PAVED SHOULDERS	TOP REINFORCEMENT COVER	TYPE OF REINFORCEMENT
Less than 4”	2½”	Epoxy coat all bars within 4” of the top of deck
Greater than 4” but less than 24”	2½”	Plain bars
24” or greater	2”	Plain bars

Apply a waterproof membrane as specified in Section 511 of the Standard Specifications to the top slab of all buried culverts. Use waterproof membrane Type D when ballast and asphalt pavement are placed across the culvert. Use waterproof membrane Type E when only asphalt pavement is placed across the culvert.

Concrete shall have a minimum compressive strength of 4 ksi.

Reinforcement shall have a minimum yield strength of 60 ksi.

Spacing of reinforcement should be in accordance with Article 5.10.3 and concrete cover should be in accordance with Article 5.10.1.

Fillets should have a minimum leg of 6”. The maximum leg should be less than the 12” for canals and 24” for streams to keep the fillet out of the waterway cross-section.

Concrete Dead Load. Assume 150 lbs/ft^3 for the concrete and reinforcement (Table 3.5.1-1 & C3.5.1).

Wearing Surface. Assume a future overlay of 6” with a weight of 140 lbs/ft^3 (Table 3.5.1-1).

Earth Fill D.L. Use the density given in the Geotechnical Engineering Report. When not given assume 140 lbs/ft^3 (rolled gravel from table
3.5.1-1). The earth loads should be modified to account for soil-structure interaction specified in Article 12.11.2.2.

Earth Pressure. Assume to be linearly proportional to the depth of the soil based on the at rest pressure coefficient specified in Article 3.11.5.2.

Earth Surcharge. When the structure is buried, the fill above the deck is considered an earth surcharge and a constant uniform horizontal earth pressure shall be applied in addition to the basic earth pressure. The uniform horizontal pressure due to earth surcharge should be based on the at rest coefficient specified in Article 3.11.6.1.

Live Load Surcharge. Live load surcharge shall be determined as specified in Article 3.11.6.4.

Live Loads. Live loads and live load distribution shall be determined as specified in Article 12.11.2.

Water Pressure. Culverts should be designed assuming static water pressure on the inside of the walls for the full design height.

PRECAST BOX CULVERTS

- Precast Wing Walls and Barrel Walls shall be double reinforced.
- Precast wing walls shall have a minimum thickness of 8".
- Top slab thickness shall be a minimum of 8" or (S +10)/30 whichever is greater (Table 2.5.2.6.3-1 for continuous spans) for structures that are designed. The span length to determine the minimum thickness is the clear span between walls.
- Minimum standard dimensions and reinforcement for Precast box culverts are shown in AASHTO M259 (ASTM C1577) and AASHTO M273 (ASTM C850). These structures will require design calculations to verify the reinforcement provided.
- For simplification in determining the shears and moments in the structure, the foundation soil pressure on box culverts may be considered to be uniformly distributed across the floor for all load cases.

PRECAST STIFFLEG CULVERTS

- Precast Wing Walls and Barrel Walls shall be double reinforced.
- Precast wing walls shall have a minimum thickness of 8".
- Slab thickness shall be a minimum of 8" or (S +10)/30 whichever is greater (Table 2.5.2.6.3-1 for continuous spans). The span length to determine the minimum thickness is the clear span between walls.
- Precast stiffleg walls shall be a minimum of 8" for spans under 24' and 10" for spans 24' and larger as specified in Article 12.14.4.
- The minimum footing width should be 2' on rock and 3' on other materials.

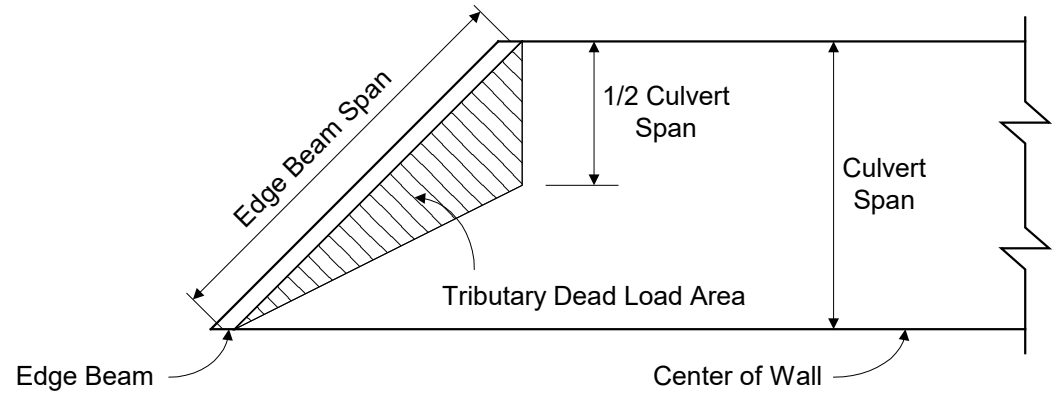
CAST-IN-PLACE CULVERTS

- Slab thickness shall be a minimum of 8" or (S +10)/30 whichever is greater (Table 2.5.2.6.3-1 for continuous spans). The span length to determine the minimum thickness is the clear span between walls.
- Main reinforcement for skews greater than 25° (Article 9.7.1.3) shall be placed perpendicular to the centerline of the culvert. For skews 25° or less, the main reinforcement should be placed on the skew and the design span measured along the skew.
- Cast-In-Place Wing Walls and Barrel Walls shall be double reinforced and have a minimum thickness of 10".
- The minimum footing width for stifflegs should be 2' on rock and 3' on other materials.
- For simplification in determining the shears and moments in the structure the foundation soil pressure on box culverts may be considered to be uniformly distributed across the floor for all load cases.
- Construction joints with keyways should be placed transverse to the barrel and should be located in the walls, top slab, and bottom slab. Joint spacing should not exceed 40'. In lieu of a construction joint in the walls, the contractor may substitute an approved contraction joint.

EDGE BEAM DESIGN

The Live Load on edge beams shall be one line of wheels (either truck or tandem) plus a tributary portion of the lane load (Art. 4.6.2.1.4b). The tributary portion of the lane load shall be considered to be a uniform load of 64 lbs/ft^2 on either the effective edge beam width, or in the case where the edge beam is skewed relative to the main slab reinforcement, on the same tributary area as defined for dead load. The effective edge beam width for culverts with main slab reinforcement parallel with the edge beam shall be the distance between the edge of deck and the inside face of the barrier or curb, plus 12", plus one-quarter of the strip width, E, determined above. The effective width shall not exceed either one-half the full strip width or 72" (Art. 4.6.2.1.4b). The dead load should be the weight of all structure components and the fill on the effective width. When the end of the culvert is skewed relative to the main slab reinforcement the dead load applied to the edge beam shall also include the weight of all loads on the tributary area at the end of the culvert as shown below. These loads may be applied to the edge

beam as a uniform load. The edge beam should be designed as a simple span with a span length based on center-of-wall to center-of-wall along the skew.



Footing Pressures

The dead load footing pressures on the footings of stifflegs and the floor of box culverts may be uniformly distributed to the total footing area. The live load footing pressures may be assumed to act on a length of footing equal to the width of the design lane plus 1.15 times the distance from the surface to the bottom of the footing (this is the same distribution rate as the live load on the fill over a buried structure). Overlapping areas from more than one lane loaded shall be uniformly distributed over the length of the overlapping regions, multiple presence factors shall be applied where applicable. The total design loaded length shall not exceed the actual footing length. The footing pressure should be assumed to be uniform across the width of the footing or floor. Foundation design shall be in accordance with Section 10 of the LRFD Code.

Wing Wall Design

Live load surcharge shall be applied where vehicular load is expected to act on the surface of the backfill within a distance equal to one-half the wall height behind the back face of the wall. H_{eq}, the equivalent height of soil in feet, should be based on Table 3.11.6.4-2.

The typical wing wall on a spread footing is free to deflect at the top under soil pressure and may therefore be designed using soil pressures based on the active state. The soil pressure coefficient, k_a, may be determined by the Coulomb method from the information in the Geotechnical Engineering Report.

Foundation design shall be in accordance with Section 10 of the LRFD Code.

Revisions:

Nov 2019	Reformatted the article to delete copying AASHTO LRFD Manual data.
Oct 2023	Corrected reference to Phase IV Report to Geotechnical Engineering Report.