Detail the height of draped strands at beam ends and at midspan at multiples of 2-in.

Do not place straight strands above draped strands in the same vertical column.

308.2.3.4.b CAMBER

C308.2.3.4.b

The concrete topping thickness on prestressed I-beam superstructures will vary along the length of the beams to account for beam camber and other vertical elevation adjustments. Proper determination of the topping thickness is crucial in order to properly establish beam seat elevations.

As shown in BDM Figure 308-6, determine the concrete topping thickness (T_x) at any point, x, along the length of a prestressed I-beam superstructure by the following:

$$T_x = A + B_x + C + D_{t,x} - E$$

Where:

A	=	Design deck thickness
B_x	=	Vertical grade adjustment
C	=	Sacrificial haunch depth
$D_{t,x}$	=	Beam camber adjustment at member age equal to Day t
E	=	Haunch adjustment

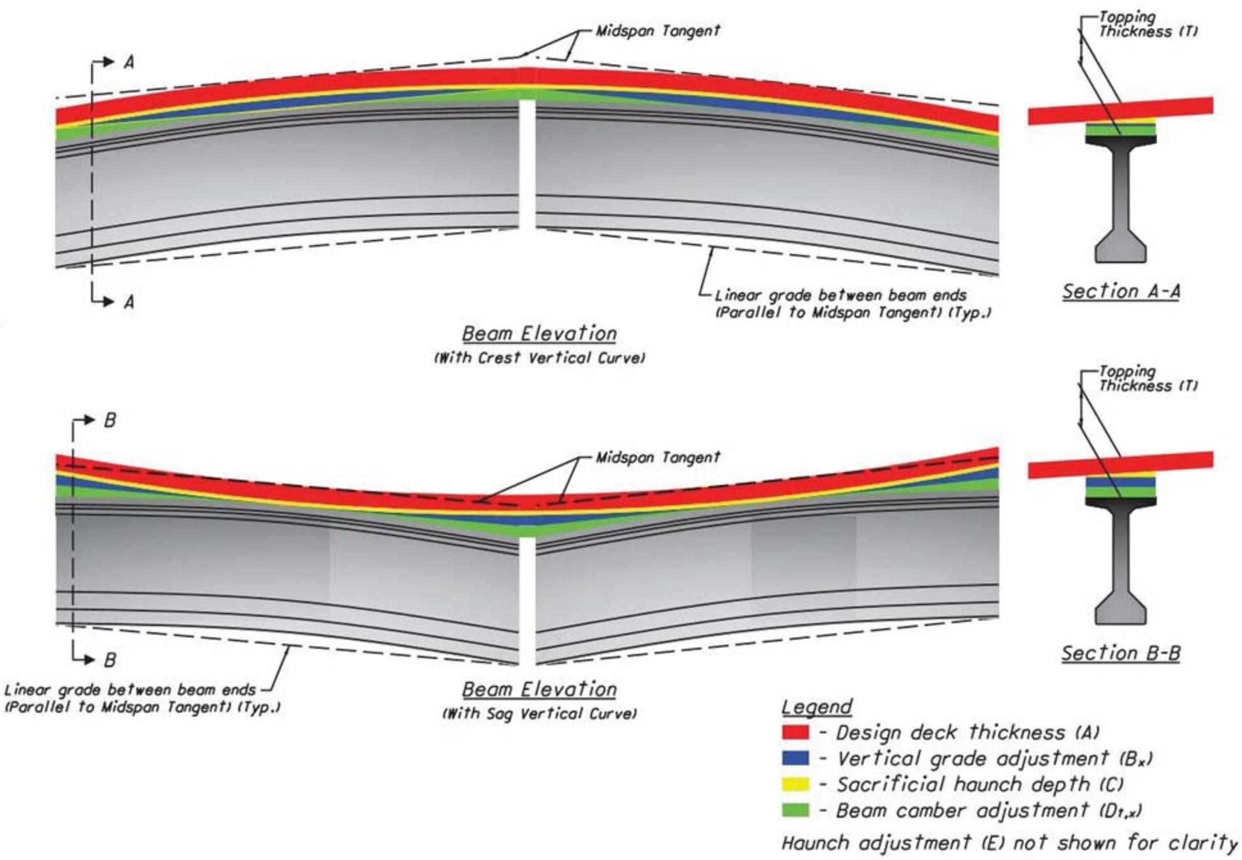

Figure 308-6

Include additional haunch reinforcement when the haunch depth reaches 4-in. ($B_x + C + D_{t,x} - E \leq$ 4-in) for the sections shown in Bridge Standard Drawing PSID-1-13. Detail additional haunch reinforcement as shown in BDM Figure 308-7. Show the locations of the additional haunch reinforcement in the plans.

In order to ensure the entire haunch depth acts compositely with the beam and deck, additional reinforcement may be necessary to extend the beam's composite reinforcement at least 2-in into the deck thickness.

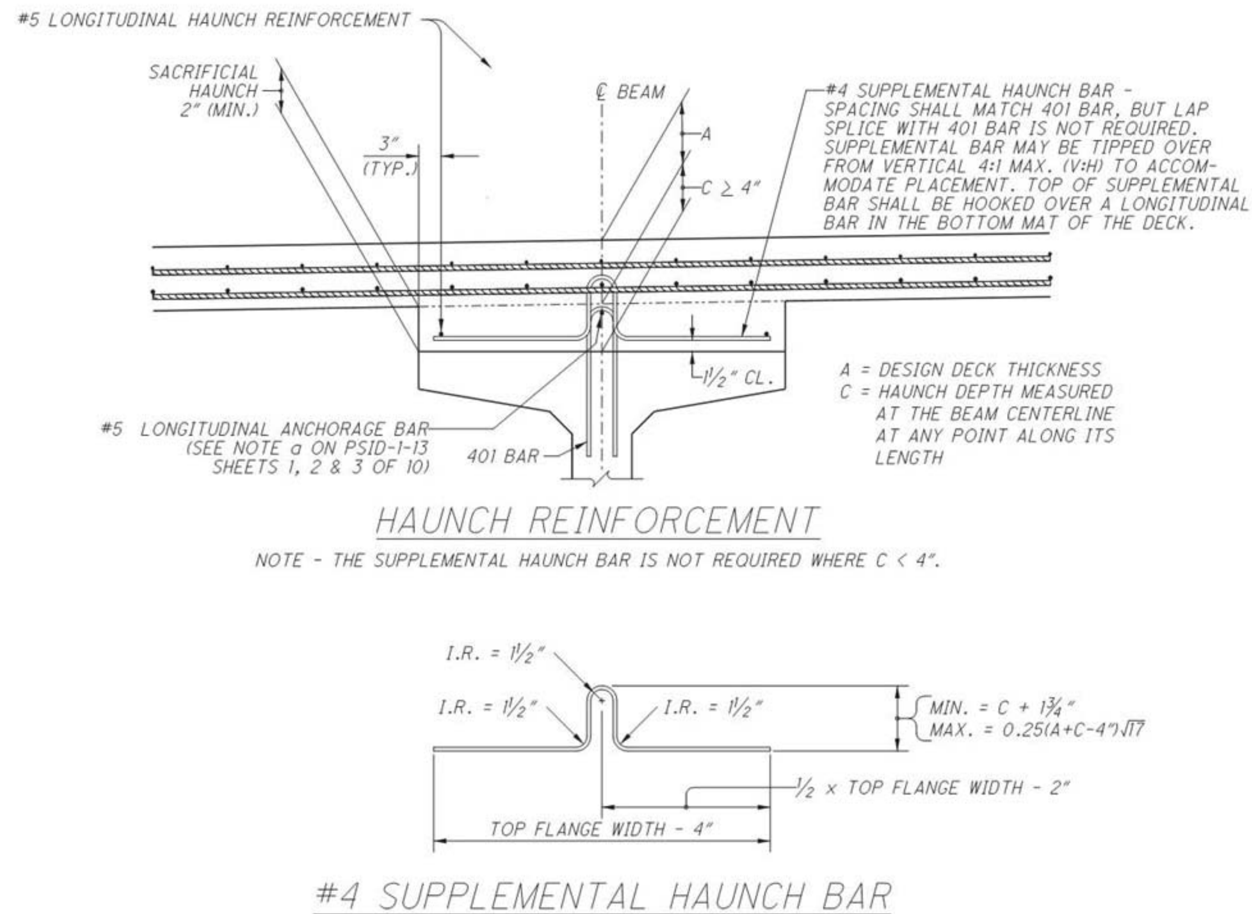

Figure 308-7

308.2.3.4.b.1 VERTICAL GRADE ADJUSTMENT (B_x)

Minimize the vertical grade adjustment along the length of the bridge by setting the linear grade between the beam ends parallel to the tangent of the vertical grade at the midpoint of the beam span (see BDM Figure 308-6).

C308.2.3.4.b.1

The Vertical Grade Adjustment accounts for any elevation differences between a non-linear profile grade and the linear grade connecting the centerline of beam supports. The value of the Vertical Grade Adjustment depends on many geometric factors such as vertical curvature, skew, cross-slope transitions, etc.

308.2.3.4.b.2 SACRIFICIAL HAUNCH DEPTH (C)

Design the Sacrificial Haunch Depth (C) to be a minimum of 2-in.

Detail the haunch so the 2-in minimum thickness, C, will occur at a flange edge. Show this requirement in

C308.2.3.4.b.2

The purpose of the Sacrificial Haunch Depth is to account for camber in excess of that calculated in the Beam Camber Adjustment above and account for the roadway cross-slope.

Because I-beams are set on level seats, the beams will be plumb after erection. The difference between the

the plans.

grades of the top flange and the cross-slope will be accommodated by the sacrificial haunch depth.

308.2.3.4.b.3 BEAM CAMBER ADJUSTMENT ($D_{t,x}$)

C308.2.3.4.b.3

As prestressed concrete beams age, beam camber will increase due to concrete creep under the constant loading from the prestressing force. Although designers cannot accurately predict the girder age when the deck is placed, general assumptions can be made to prevent camber growth from becoming an issue during construction.

Show two values for camber at midspan in the design plans which the contractor can use to establish seat elevations according to C&MS 511.07 and tolerance according to C&MS 515.17: camber at Day 0 (D_0) and camber at Day 30 (D_{30}). These values represent the midspan camber in the beams before application of any dead load other than self-weight.

To determine these camber values, calculate the creep coefficient, $\psi(t,t_i)$, according to *LRFD 5.4.2.3.2* with humidity (H) equal to 70%; age of concrete at release (t_i) equal to 0.75 days; and V/S and f'_{ci} according to the project requirements. To calculate the creep coefficient at Day 0 and Day 30, use a maturity of concrete (t) equal to 0 days and 30 days respectively. The respective camber values are found by multiplying the net midspan camber at the time of release by the appropriate creep coefficient as follows:

$D_{30} = [1+ \psi(t,t_i)]\ D_0$

The net camber at the time of release ($\delta_{net,x}$) is the difference between the initial beam camber due to the prestressing force ($\delta_{o,x}$) and beam deflection due to self-weight ($\delta_{sw,x}$) [i.e. $\delta_{net,x} = \delta_{o,x} - \delta_{sw,x}$].

The gross moment of inertia for the non-composite I-beam may be used to determine $\delta_{o,x}$ and $\delta_{sw,x}$.

For the purposes of determining the topping thickness, calculate the final Beam Camber Adjustment ($D_{t.x}$) at any point, x, along the length of the beam as follows:

$$D_{t,x} = \left[\left(\delta_{net,mid} - \delta_{net,x}\right)\left(1 + \psi(t,t_i)\right)\right] - \left[\left(\delta_{NC,mid} + \delta_{C,mid}\right) - \left(\delta_{NC,x} + \delta_{C,x}\right)\right]$$

Where:

$\delta_{net,mid}$	=	Net camber at mid-span
$\delta_{net,x}$	=	Net camber at point x
$\delta_{NC,mid}$	=	Deflection due to non-composite loading at mid-span
$\delta_{C,mid}$	=	Deflection due to composite loading at mid-span
$\delta_{NC,x}$	=	Deflection at point x due to non-composite loading
$\delta_{C,x}$	=	Deflection at point x due to composite loading
$\psi(t,t_i)$	=	Creep coefficient

(Note: The equation shown for $D_{t,x}$ assumes camber is upward and deflections are downward.)

To establish beam seat elevations, calculate the Beam Camber Adjustment using the creep coefficient at t equal to 30 days.

308.2.3.4.b.4 HAUNCH ADJUSTMENT (E)

Calculate the Haunch Adjustment (E) as follows:

$E = B_{mid} \leq \text{Max } D_{t,x}$

C308.2.3.4.b.4

The Haunch Adjustment is the portion of the Beam Camber Adjustment that can be utilized for Vertical Grade Adjustment in crest vertical curve profiles only. This adjustment prevents the haunch from becoming excessive along the full length of the beam.

The Haunch Adjustment is equal to the Vertical Grade Adjustment at the beam midspan (B_{mid}) but cannot exceed the maximum value for $D_{t,x}$.

308.2.3.4.c ANCHORAGE

Provide 1-in. diameter anchors at each fixed pier as shown on bridge standard drawing PSID-1-13.

Determine the required number of anchors by analysis. Design the anchors to transfer superstructure loads to the substructure at the Strength Limit States and resist seismic loads at Extreme Event Limit State.

Use anchors with a minimum length of 2-ft. Embed the anchors a minimum of 1-ft into the pier cap. Post install (drill and grout) the anchors at the centerline of at the pier. Confirm the pier cap has reinforcing steel clearance to accept these anchors.