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Grid Reinforced Concrete Deck Overhang Design Guidelines

Combination concrete parapet and metal railing.

Six test levels for bridge railings are provided in Section 13 of the **AASHTO LRFD Bridge Design Specifications**, which correspond to the test levels found in the NCHRP Report 350, *"Recommended Procedures for the Safety Performance Evaluation of Highway Features."* Lower test levels correspond to lower service level roadways. Higher test levels correspond to higher levels of service roadways or when required for unfavorable site conditions. For the most part, railings that satisfy the minimum requirements of Test Level Four (TL-4) are considered satisfactory for the majority of interstate design requirements.

Barrier rebar extending from cast-in-place deck.

Barrier systems need to be shown that they are structurally and geometrically crashworthy and reinforcing steel from the barrier must have sufficient embedment length to develop the yield strength. Decks are designed on a case-by-case basis and are not individually crash tested when crash testing barriers. Therefore, proper design of the deck overhang is essential to ensure that in a collision, the damage to the structure will be contained in the barrier and not extend to the deck. To achieve this, the deck should be designed stronger than the railing system. This will facilitate repair of the crash damage and minimize the cost to perform the repairs. However, yield line analysis of many barriers has shown that the resistance (R_w) of the barrier greatly exceeds the imposed design collision force (F_t) specified in AASHTO Table A13.2-1. For these situations, several state departments of transportation stipulate that the deck overhang shall carry the lesser of the calculated barrier capacity (R_w) or a percentage of design collision force (F_t), say 120% or 133%.

With vehicular collisions, a tensile force (T) is transmitted to the deck per unit width and can be calculated with AASHTO Equation A13.4.2-1. FHWA Publication HI-95-017 cites that continuous concrete barriers conservatively distribute the load a distance (L) at 30° from the limits of the critical wall length of the yield line failure pattern (L_c) at the face of the barrier to the design section for negative moment over the fascia girder.

Although Section 13 in the AASHTO LRFD Specification was developed for conventional reinforced concrete decks, the guidelines are applicable to grid reinforced concrete decks as well. In accordance with AASHTO A13.4.1, bridge deck overhangs shall be designed for the following design cases considered separately:

- *Design Case 1* - Transverse and longitudinal forces specified in Article A13.2 & Extreme Event Load Combination II limit state.
- *Design Case 2* - Vertical forces specified in Article A13.2 & Extreme Event Load Combination II limit state.
- *Design Case 3* - Loads specified in Article 3.6.1 that occupy the overhang & Load Combination Strength I limit state.

Concrete barrier being placed during slip-form operation.

Design Case 1

In Design Case 1, the deck overhang supporting a continuous concrete barrier must have a moment resistance (M_s) in the presence of tensile force (T), equal to the sum of the moment of resistance of the barrier at its base (M_c) and the dead load moments, i.e., $M_S \geq M_{DL} + M_C$. Although the colliding vehicle is on the bridge, crash testing observations show that the wheels near the barrier were not in contact with the deck at moment of the collision. Therefore, the traditional live load effects need not be included in this case.

Design Case 2

For instances with continuous concrete parapets and combinations of concrete parapet and metal railings, Design Case 2 produces relatively small force effects and can therefore be ignored.

Design Case 3

Design Case 3 is the conventional design of the overhang considering the dead loads and the design truck wheel live load placed no closer than 1'-0" from the face of the barrier in accordance with Section 3.6.1.3.1. The width of the equivalent strip for load distribution shall be calculated in accordance with Section 4.6.2.1.3 for overhangs.

Depending on the system specified, grid reinforced concrete deck overhangs can cantilever approximately 30% to 50% of the design interior span and may be increased with additional reinforcement. See the attached sample calculations for an unfilled grid deck composite with reinforced concrete slab which follow the AASHTO LRFD design requirements.

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