Roadway Departure Technical Brief No. 5

Transitioning metal beam guardrail to existing bridge railings

CATEGORY: Design

ISSUE: While current design standards include details for connecting approach metal beam guardrail to bridge railings on new bridge construction, transitioning new metal beam guardrail to existing bridge railings often presents a challenge. Bridge railings on many existing structures vary considerably and currently-acceptable transition designs do not "fit" some of the older designs. The challenge is to modify the transition in such a way that it remains crashworthy by effectively shielding the bridge rail end.

OBJECTIVE: Provide guidelines to designers that will aid them in designing a crashworthy transition for attachment to a non-standard bridge rail.

METHODOLOGY: This document will identify the critical design issues that must be addressed when a crashworthy transition must be connected to a non-standard bridge rail end. It will also identify situations where continuing a metal beam guardrail across the structure is a cost-effective method of improving the bridge railing itself and simplifying the transition design.

GENERAL: There are three major design requirements for crashworthy transition designs:

1. The transition must be structurally connected to the bridge rail when practical, i.e., the metal beam rail should not pull out of bridge rail end.
2. The transition design must be gradually stiffened between the semi-rigid approach railing itself and the rigid bridge railing. An impacting vehicle should be gradually and smoothly redirected past the bridge rail end without deflecting the transition enough to cause "pocketing" and sudden deceleration.
3. The transition design and its connection at the bridge rail must minimize the likelihood of wheel snagging (under the transition) or vehicle snagging (if the bridge rail is much taller than the top of the transition rail).

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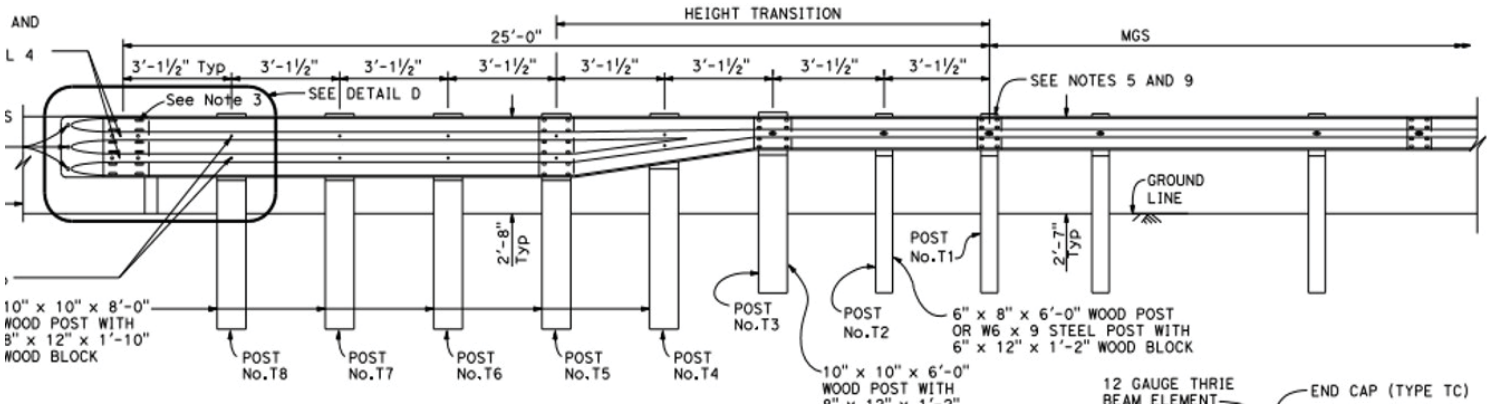
EXPECTED RESULTS:

Provides designers with information needed to connect an effective bridge terminal assembly (transition) to an existing, non-standard bridge railing or parapet.

Connecting an approach metal beam guardrail to a new bridge rail is simply a matter of using current standard drawings and specifications. Some DOTs have developed modified designs for connecting approach rail to several existing bridge rail designs even though the railing is no longer used on new construction. Caltrans MGS transition design for new construction is shown below.



There remain many older bridges still in service for which bridge terminal assemblies may or may not have been developed. When approach barrier is being upgrading on these structures, the DOT Bridge Division should be contacted for possible retrofit designs. The primary requirements for any metal beam guardrail-to-bridge parapet design listed on the previous page should be met – to the extent practical. These design criteria are repeated here along with suggested ways of satisfying them:

1. Structural Connection: The need to anchor the downstream end of the transition is obvious – if the rail pulled free on impact, a vehicle would strike the end of the bridge parapet and come to a sudden stop. However, if the existing parapet is not strong enough to anchor the transition, a second option would be to continue the beam guardrail over the structure. This treatment can also have the benefit of increasing the capacity of an existing bridge railing and blocking out any "safety curb" that may be present. A curb in front of a bridge rail increases the chances of a vehicle vaulting over the bridge rail after impact with the curb. Finally, if the existing railing cannot support a transition and it is not practical to continue the beam rail across the structure, an independent anchor to which the transition could be connected can be constructed immediately off the bridge as shown in the photograph.
2. Gradual Stiffening: Even if the rail does not pull loose from the parapet, the approach metal beam guardrail and the bridge terminal attachment must not deflect enough to create a "pocket" in the rail that would stop the vehicle too suddenly and prevent its safe containment or redirection. This stiffening is accomplished by a combination of design elements, including a reduction in the post spacing, sometimes accompanied by the use of larger and/or longer posts, and by doubling the thickness of the beam by nesting two sections together.
3. Minimizing Vehicle Snagging: In a high-speed impact, the wheels of a vehicle tend to fold underneath the rail. If allowed to do so, the resultant snagging may cause the vehicle to spin out of control. To prevent this from happening, some transition designs include a second w-beam guardrail to prevent a wheel from sliding under the transition. While sometimes overlooked, it is also recommended that the top of the bridge transition assembly match the top of the bridge parapet or that the parapet be sloped to match the transition. When a vehicle such as a large truck or a passenger van impacts the approach railing, it can lean over the top of the railing and strike any vertical object in line with or immediately behind to the railing.