13.1 SCOPE

C13.1

Revise the 2nd Paragraph as follows:

The bridge railing performance need not be identical over the whole highway network. New railing designs should match site needs leading to a multiple test level concept, as described in NCHRP Report 350 or AASHTO's *Manual for Assessing Safety Hardware* (MASH).

Delete the 3rd Paragraph and replace with the following:

All highway safety hardware accepted prior to the adoption of AASHTO, *Manual for Assessing Safety Hardware* (MASH), using criteria contained in NCHRP Report 350, may remain in place and may continue to be manufactured and installed. Highway safety hardware accepted using NCHRP Report 350 criteria is not required to be retested using MASH criteria. New highway safety hardware not previously evaluated must utilize MASH for testing and evaluation.

13.2 DEFINITIONS

Revise the following definition as follows:

Crash Testing of Bridge Railings—Conducting a series of full-scale impact tests of a bridge railing in accordance with the recommended guidelines in NCHRP Report 350 or AASHTO's *Manual for Assessing Safety Hardware* in order to evaluate the railing's strength and safety performance.

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13.3 NOTATION

Revise as follows:

b = ~~length of deck resisting post strength or shear load = $h + W_b$ (A13.4.3.2)~~
length of deck resisting post strength or shear load (ft.) (A13.4.3.1)

~~D = depth of base plate (in.) (A13.4.3.2)~~

d_b = distance from the outer edge of the base plate to the innermost row of bolts (ft.) (in.) (A13.4.3.1)(A13.4.3.2)

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13.4 GENERAL

C13.4

Revise the 6th Paragraph as follows:

Procedure for testing railing are given in AASHTO's *Manual for Assessing Safety Hardware* ~~NCHRP Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features~~.

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13.7.2 Test Level Selection Criteria

C13.7.2

Revise the 1st Paragraph as follows:

The six test levels mentioned herein are intended to correspond with the six test level contained in AASHTO's *Manual for Assessing Safety Hardware* and NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*.

Revise the 7th Paragraph as follows:

These criteria, including other vehicle characteristics and tolerances, are described in detail in AASHTO's *Manual for Assessing Safety Hardware* and the NCHRP Report 350.

13.7.2 Test Level Selection Criteria

Table 13.7.2-1 Bridge Railing Test Levels and Crash Test Criteria

Revise the table as follows:

	Vehicle Characteristics	Small Automobiles		Pickup Truck	Single-Unit Van Truck	Van-Type Tractor-Trailer		Tractor-Tanker Trailer
NCHRP Report 350	*W* (kips)	1.55	1.8	4.5	18.0	50.0	80.0	80.0
	B (ft.)	5.5	5.5	6.5	7.5	8.0	8.0	8.0
	G (in.)	22	22	27	49	64	73	81
	Crash angle, θ	20°	20°	25°	15°	15°	15°	15°
	Test Level	Test Speeds (mph)						
	TL-1	30	30	30	N/A	N/A	N/A	N/A
	TL-2	45	45	45	N/A	N/A	N/A	N/A
	TL-3	60	60	60	N/A	N/A	N/A	N/A
	TL-4	60	60	60	50	N/A	N/A	N/A
	TL-5	60	60	60	N/A	N/A	50	N/A
	TL-6	60	60	60	N/A	N/A	N/A	50
AASHTO MASH	*W* (kips)	2.42	3.3	5.0	22.0	N/A	79.3	79.3
	B (ft.)	5.5	5.5	6.5	7.5	N/A	8.0	8.0
	G (in.)	N/A	N/A	28	63	N/A	73	81
	Crash angle, θ	25°	N/A	25°	15°	N/A	15°	15°
	Test Level	Test Speeds (mph)						
	TL-1	30	N/A	30	N/A	N/A	N/A	N/A
	TL-2	45	N/A	45	N/A	N/A	N/A	N/A
	TL-3	60	N/A	60	N/A	N/A	N/A	N/A
	TL-4	60	N/A	60	55	N/A	N/A	N/A
	TL-5	60	N/A	60	N/A	N/A	50	N/A
	TL-6	60	N/A	60	N/A	N/A	N/A	50

13.7.3.1.2 New Systems

Revise the 2nd Paragraph as follows:

The crash test specimen for a railing system may be designed to resist the applied loads in accordance with Appendix A of this Section ~~or NCHRP Report 350 with its revisions~~.

13.7.3.2 Height of Traffic Parapet or Railing

C13.7.3.2

Revise the 1st Paragraph as follows:

These heights have been determined as satisfactory through crash tests performed in accordance with NCHRP Report 350 and experience.

13.8 PEDESTRIAN RAILING

13.8.1 Geometry

Revise as follows:

The minimum height of a pedestrian railing shall be 42.0 in. measured from the top of the walkway.

A pedestrian rail may be composed of horizontal and/or vertical elements. The clear opening between elements shall be such that a ~~6.0~~ 4.0 in. diameter sphere shall not pass through.

~~When both horizontal and vertical elements are used, the 6.0 in. clear opening shall apply to the lower 27.0 in. of the railing, and the spacing in the upper portion shall be such that a 8.0 in. diameter sphere shall not pass through.~~ A safety toe rail or curb should be provided. Rails should project beyond the face of posts and/or pickets as shown in Figure A13.1.1-2.

The rail spacing requirements given above should not apply to chain link or metal fabric fence support rails and posts. Mesh size in chain link or metal fabric fence should have openings no larger than 2.0 in.

C13.8.1

Revise as follows:

The Americans with Disabilities Act (ADA) of 1990, along with it's implementing regulations, and the California Government Code Section 4450 et Esq. prescribe that facilities shall be made accessible to persons with disabilities. To comply with the ADA, California Department of Transportation facilities in the highway environment are to follow the guidance included in Design Information Bulletin (DIB) 82. In accordance with DIB 82, pedestrian rail openings shall be spaced such that a 4.0-inch diameter sphere cannot pass through.

The size of openings should be capable of retaining an average size beverage container.

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13.9 BICYCLE RAILINGS

13.9.1 General

Bicycle railings shall be used on bridges specifically designed to carry bicycle traffic and on bridges where specific protection of bicyclists is deemed necessary.

13.9.2 Geometry

Revise as follows:

The height of a bicycle railing shall not be less than 42.0 in., measured from the top of the riding surface.

The clear opening between elements shall be such that a 6.0 in. diameter sphere shall not pass through. When both horizontal and vertical elements are used, the 6.0 in. clear opening shall apply to the lower 27.0 in. of the railing, and the spacing in the upper portion shall be such that an 8.0-in. diameter sphere shall not pass through.

The bicycle rail shall be offset a minimum of 15 inches behind the face of the vehicular rail if the bike rail and the vehicular rail were not successfully crash tested as an integral unit.

~~The height of the upper and lower zones of a bicycle railing shall be at least 27.0 in.~~ When pedestrian traffic is anticipated, the upper and lower zones shall have rail spacing satisfying the respective provisions of Article 13.8.1.

If deemed necessary, rubrails attached to the rail or fence to prevent snagging should be deep enough to protect a wide range of bicycle handlebar heights.
If screening, fencing, or a solid face is utilized, the number of rails may be reduced.

C13.9.2

Revise as follows:

Railings, fences or barriers on either side of a shared use path on a structure, or along bicycle lane, shared use path or signed shared roadway located on a highway bridge should be a minimum of 42.0 in. high. The 42.0-in. minimum height is in accordance with the *AASHTO Guide for the Development of Bicycle Facilities*, 3rd Edition (*1999*).

On such a bridge or bridge approach where high-speed high-angle impact with a railing, fence or barrier are more likely to occur (such as short radius curves with restricted sight distance or at the end of a long descending grade) or in locations with site-specific safety concerns, a railing, fence or barrier height of 48 inches ~~above the~~ (minimum) should be considered.

The 15-inch bicycle rail offset behind the face of the vehicular rail is required to maintain the vehicular crash test certification if the vehicular rail and bicycle rail were not successfully crash tested as an integral unit.

Anticipated pedestrian traffic does not include occasional pedestrian presence due to vehicle breakdowns.

The need for rub rails attached to a rail or fence is controversial among many bicyclists.

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REFERENCES

Add the following reference:

AASHTO. 2009. *Manual for Assessing Safety Hardware*, MASH-1. American Association of State Highway and Transportation Officials, Washington, DC.

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A13.3.2 Post-and-Beam Railings

Revise as follows:

where:

L = post spacing or single-span (ft.)

M_p = inelastic or yield line resistance of all the rails contributing to a plastic hinge (kip-ft.)

M_{post} = plastic moment resistance of a single post (kip-ft.)

P_p = shear force on a single post which corresponds to M_{post} and is located $\overline{Y}$ above the deck (kips)

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A13.4.2 Decks Supporting Concrete Parapet Railings

Revise as follows:

For Design Case 1, the deck overhang shall ~~may~~ be designed to resist ~~provide a flexural resistance, M_S in kip-ft./ft. which, acting coincident with~~ the combined effects of tensile force T in kip/ft.~~,~~ and moment M_{ct} as specified herein, ~~exceeds M_C of the parapet at its base. The axial tensile force, T, may be taken as:~~

$$\cancel{T = \frac{R_w}{L_c + 2H}}$$

$$T = 1.2\left(\frac{F_t}{L_c}\right) \qquad \text{(A13.4.2-1)}$$

$$M_{ct} = 1.2\left(\frac{F_t H}{L_c}\right) \qquad \text{(A13.4.2-2)}$$

where:

~~R_w = parapet resistance specified in Article A13.3.1 (kips)~~

L_c = critical length of yield line failure pattern (ft.). In the absence of more accurate calculations, L_c, may be taken as 10 ft for Caltrans Standard Barriers Type 25, Type 732, Type 736, and Type 742; this value of L_c is valid for design forces TL-1 through TL-4 shown in Table A13.2-1. At the location of expansion joints, the value of L_c shall be half that specified above.

H = height of wall (ft.)

T = tensile force per unit of deck length (kip/ft.)

M_{ct} = moment in the deck overhang due to F_t (kip/ft.-ft.)

Design of the deck overhang for the vertical forces specified in Design Case 2 shall be based on the overhanging portion of the deck.

CA13.4.2

Delete the 1st and 2nd Paragraphs and replace with the following:

In the design of barrier rails, it is recognized that the crash testing program is oriented towards survival, not necessarily the identification of the ultimate strength of the railing system. This typically produces a railing system that is significantly overdesigned, and in turn would lead to an over-design of the deck overhang that may not be practical.

Therefore, the design of deck overhang for Design Case 1 is based on F_t, the transverse force on the barrier rail corresponding to the Test Level as shown in Table A13.2-1, not on the capacity of the barrier rail. To account for uncertainties in the load and mechanisms of failure, and to provide an adequate safety margin, the actual design tensile force acting on the deck overhang and the corresponding design moment obtained through statics are increased by 20%.

When Type 26 barrier rail is used, the design variables for overhang design should be taken as the same as those for Type 732 since barrier upgrade at a later date is possible. For other barrier types not listed, a more a more rigorous calculation should be made to compute L_c.

At an expansion joint, and at the beginning and end of a bridge, the value of L_c will be half that at intermediate locations. This will cause an increase in demands in the overhang region. Consequently, the top reinforcing bars in the overhang should be designed to accommodate this increased demand in this region.

A13.4.3.1 Overhang Design

Revise as follows:

$$M_d = \frac{M_{post}}{W_b + d_b} \quad \text{(A13.4.3.1-1)}$$

$$T = \frac{P_p}{W_b + d_b} \quad \text{(A13.4.3.1-2)}$$

CA13.4.3.1

Revise as follows:

~~Beam and post railing systems, such as a metal system with wide flange or tubular posts, impose large concentrated forces and moments on the deck at the point where the post is attached to the deck.~~

Vehicle collision on the beam and post railing systems, such as a metal system with wide flange or tubular posts, imposes large concentrated forces and moments on the deck at the point where the post is attached to the deck.

A13.4.3.1 Overhang Design

Revise as follows:

where:

M_{post} = ~~flexural resistance of railing post (kips)~~ plastic moment resistance of a single post (kip-ft.)

P_p = ~~shear corresponding to M_{post} (kips)~~ shear force on a single post which corresponds to M_{post} and is located $\overline{Y}$ above the deck (kips)

X = distance from the outside edge of the post base plate to the section under investigation, as specified in Figure 1 (ft.)

W_b = width of base plate (ft.)

T = tensile force in deck (kip/ft.)

~~D~~ d_b = distance from the outer edge of the base plate to the innermost row of bolts, as shown in Figure 1 (ft.)

L = post spacing (ft.)

L_v = longitudinal distribution of vertical force F_v on top of railing (ft.)

F_v = vertical force of vehicle laying on top of rail after impact forces F_t and F_L are over (kips)

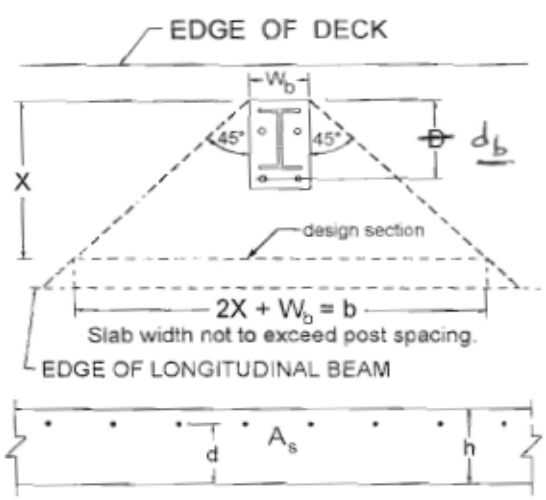

Figure A13.4.3.1-1 Effective Length of Cantilever for Carrying Concentrated Post Loads, Transverse or Vertical.

A13.4.3.2 Resistance to Punching Shear

Revise as follows:

The factored resistance of deck overhangs to punching shear may be taken as:

$$V_r = \phi V_n \qquad \text{(A13.4.3.2-2)}$$

$$V_n = v_c \left[W_b + h + 2\left(E + \frac{B}{2} + \frac{h}{2} \right) \right] h \qquad \text{(A13.4.3.2-3)}$$

$$v_c = \left(0.0633 + \frac{0.1265}{\beta_c} \right) \sqrt{f'_c} \le 0.1265 \sqrt{f'_c} \qquad \text{(A13.4.3.2-4)}$$

$$\frac{B}{2} + \frac{h}{2} \le B \qquad \text{(A13.4.3.2-5)}$$

in which:

$\beta_c = W_b/D$

β_c = larger of W_b/d_b *or* d_b/W_b (A13.4.3.2-6)

A13.4.3.2 Resistance to Punching Shear

Revise as follows:

β_c = ratio of the long side to the short side of the concentrated load or reaction area

f'_c = 28-day compressive strength of concrete (ksi)

ϕ = resistance factor

~~D = depth of base plate (in.)~~
d_b = distance from the outer edge of the base plate to the innermost row of bolts (in.)

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