STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

DESIGN CRITERIA FOR BRIDGES AND STRUCTURES

August 8, 2014

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
DESIGN BRANCH, BRIDGE DESIGN SECTION
601 KAMOKILA BLVD., ROOM 611
KAPOLEI, HAWAII 96707

Design Criteria for Bridges and Structures **August 8, 2014**

This document sets the design criteria for bridges and structures for the Hawaii Department of Transportation, Highways Division (HDOT). It supersedes the *Design Criteria for Bridges and Structures* dated January 7, 2014 including all previous design criteria.

If deemed necessary, the Bridge Design Engineer may recommend changes to these design criteria at any time at his/her discretion.

If there are any questions, please contact:

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1.0 <u>DESIGN REFERENCES</u>

- *AASHTO LRFD Bridge Design Specifications*, 7th edition (2014) including all subsequent interim revisions and editions. This shall govern all structural designs for bridges including retaining walls, culverts, traffic barriers, sound barriers, catch basins, drain manholes, inlet boxes, pull boxes, and similar structures within the State's right-of-way and similar structures subject to review by the Bridge Design Section except as modified herein. Seismic design for new bridges and rehabilitated bridges, as applicable, may be in accordance with the *AASHTO Guide Specifications for LRFD Seismic Bridge Design*, 2nd edition (2011) including subsequent interim revisions when directed or approved by the Bridge Design Engineer and as modified herein. The use of AASHTO *Standard Specifications for Highway Bridges,* 17th edition, shall only be allowed when checking the adequacy of existing structures designed prior to January 1997 unless the Bridge Design Engineer grants an exception.

- AASHTO *Guide Specifications for Seismic Isolation Design*, 3rd edition (2010) including all subsequent interim revisions and editions. This document provides fundamental requirements for seismic isolation design and supplements the *AASHTO LRFD Bridge Design Specifications* and the *AASHTO Guide Specifications for LRFD Seismic Bridge Design.*

- AASHTO *Guide Specifications for Bridges Vulnerable to Coastal Storms*, 1st edition (2008) including all subsequent interim revisions and editions. This shall be used as a guide for determination of wind and wave forces on bridges and structures due to coastal storms such as hurricanes.

- AASHTO *Guide Specifications for Design of Bonded FRP Systems for Repair and Strengthening of Concrete Bridge Elements*, 1st edition (2012) including all subsequent interim revisions and editions. This document provides guidelines for the design for repair and strengthening of reinforced and prestressed concrete bridge elements using externally bonded fiber-reinforced polymer (FRP) composite systems and supplements the *AASHTO LRFD Bridge Design Specifications.*

- AASHTO *Guide Design Specifications for Bridge Temporary Works*, 2nd edition (2012) including all subsequent interim revisions and editions. This shall govern design of falsework/shoring, formwork, and temporary retaining structures including cofferdams.

- AASHTO *LRFD Guide Specifications for Design of Pedestrian Bridges*, 2nd edition (2009) including all subsequent interim revisions and editions. This shall govern design of typical pedestrian bridges which are designed for and intended to carry primarily pedestrians, bicyclists, equestrian riders, and light maintenance vehicles.

- AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, 6th edition (2013) including all subsequent interim revisions and editions. This shall govern design of structural supports for highway signs, luminaries and traffic signals. This shall also govern design of other support structures such as for variable message signs, traffic management cameras, transmission lines other than overhead electrical lines and communication equipment including those attached to bridge structures except as modified herein. Supports for overhead electrical supply and communication lines, at a minimum, shall be analyzed and designed in accordance with the *National Electrical Safety Code* per the Hawaii Administrative Rules, Chapter 6-73, "Installation, Operation and Maintenance of Overhead and Underground Electrical Supply and Communication Lines".

- AASHTO *The Manual for Bridge Evaluation,* 2nd edition (2010) including all subsequent interim revisions and editions. Section 6, Part A "Load and Resistance Factor Rating" of this document shall govern the load rating requirements for HDOT bridges. This section supersedes HDOT *Implementation Guidelines for Load and Resistance Factor Rating (LRFR) of Highway Bridges,* March 27, 2008 which was based on AASHTO *The Manual for Bridge Evaluation*, 1st edition (2008).

- *International Building Code* as adopted and amended by the State Building Code Council per the Hawaii Administrative Rules, Chapter 3-180, "State Building Code". Unless otherwise directed, this shall govern structural designs for State of Hawaii DOT buildings and other structures not covered by AASHTO guidelines and specifications.

- *Earthquake Retrofit Guidelines for Bridges*, California Department of Transportation (Caltrans) Memo 20-4, latest version. All design for seismic retrofitting of existing bridges except for rehabilitation or widening projects shall be in accordance with Caltrans seismic retrofit methodology unless otherwise directed. FHWA publication *Seismic Retrofitting Manual for Highway Structures: Part 1 - Bridges*, FHWA-HRT-06-032, January 2006, may be referenced for supplemental information. Seismic retrofitting that may be required for bridge rehabilitation or widening projects shall be in accordance with the *AASHTO LRFD Bridge Design Specifications* or the *AASHTO Guide Specifications for LRFD Seismic Bridge Design* unless otherwise directed by the Bridge Design Engineer.

- Fabrication and Construction Tolerances: 1) *Hawaii Standard Specifications for Road and Bridge Construction* (2005); 2) *AASHTO LRFD Bridge Construction Specifications,* 3rd edition (2010) including all subsequent interim revisions; 3) *Standard Specifications for Tolerances for Concrete Construction and Materials* (ACI 117); 4) PCI *Tolerances for Precast and Prestressed Concrete*; and 5) *Manual for Quality Control for Plants and Production of Structural Precast Concrete Products* (PCI MNL-116), latest adopted. Tolerances for Concrete and Steel Construction and Materials shall conform to the stricter of the applicable provisions of the HDOT, AASHTO, ACI and PCI documents relating to tolerance except as modified herein and the project documents. Project documents shall reflect governing tolerance references including modifications where tighter tolerances are required.

- HDOT *Design Criteria for Highway Drainage*, latest version. This document shall be referenced for hydrologic and hydraulic analysis/design at waterway crossings for bridges and structures.

The governing edition or version of specifications, guidelines, codes or standards used for design of bridges and structures shall be:

1. **For HDOT consultant designed projects**, the requirements contained in the executed design contract including modifications thereafter as recommended by the Bridge Design Engineer;
2. **For County federal-aid projects**, the requirements at the time HDOT Bridge Design Section is consulted for a specific project (If the project is more than 2 years old, HDOT shall be consulted again.), or as noted during HDOT reviews if not previously consulted;
3. **For permit projects or non-HDOT consultant designed projects** within HDOT right-of-way, the requirements at the time HDOT Bridge Design Section is consulted for a specific project (If the project is more than 2 years old, HDOT shall be consulted again.), or as noted during HDOT reviews if not previously consulted; and
4. **For in-house designed projects**, the requirement at the time preliminary engineering is conducted and as directed by the Bridge Design Engineer thereafter.

2.0 MODIFICATIONS TO *AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS*

2.01 **Materials** [Article 2.5.2.1.1]. All cable ducts for prestressing or post-tensioning strands/tendons shall be grouted unless otherwise approved by the Bridge Design Engineer.

2.02 **Load Factors and Load Combinations** [Articles 3.4.1 and 3.7.5]. The effects of scour shall be considered in the design of bridges. Scour is not a load but is an extreme event that alters the geometry of the structure and foundation possibly causing structural collapse or the amplification of the effects of applied loads. Based on the calculated 100-year flood scour depth, the following scour factors shall be applied:

- A scour factor of 1.00 shall be considered for all strength and service load combination limit states. The case of zero scour depth and potential for differential scouring should also be investigated to determine the worst case for a particular load combination that may govern the design.

- A scour factor of 2.00 or depth to unerodible material, whichever is less, shall be used in combination with dead loads of structure only.

- A scour factor of 0.25 shall be used in combination with earthquake loads. When analyzing for effects due to earthquake loads, the case of zero scour depth shall also be investigated.

If approved scour mitigation measures are implemented, the full effects of scour need not be considered.

For design of temporary bridges, scour should be based on a flood with an expected recurrence of at least twice the number of years the temporary bridge is expected to exist but not less than 5 years.

2.03 **Dead Loads** [Article 3.5.1]. The following additional dead loads shall be considered in design of new bridges and as applicable for bridge rehabilitations.

- Weight of future wearing surface of 25 psf from curb to curb if wearing surface is not already provided in the design.

- Future utilities load on each side of the bridge of 150 plf. This should be in addition to known or existing utility loads to be supported by the structure.

2.04 **Unit Weights** [Table 3.5.1-1]

- Concrete (Normal): Use 160 pcf for unit weight of reinforced concrete. Use 150 pcf for the determination of the modulus of elasticity and when the material reduces the effect of another force.

- Concrete (Lightweight): As specified. Consult with HDOT Material Testing and Research Branch.

- Compacted Earth: 120 pcf minimum. Based on soil type, design may require 140 pcf. Consult with HDOT Material Testing and Research Branch or Geotechnical Consultant. Use 100 pcf when the material reduces the effect of another force.

2.05 **Operational Classification** [Article 3.10.5]. Unless otherwise directed, all designs for bridges shall be classified as follows:

- Except for temporary bridges, all new or replacement bridges shall be classified as essential. Temporary bridges shall be classified as "other bridges".

- Existing bridges to be rehabilitated may be classified as essential if justified being cost-effective. The designer shall conduct preliminary investigations to compare estimated costs between a bridge classified as "essential" and "other".

2.06 **General** [Article 3.10.9.1]. This article shall be amended to require seismic analysis for all bridges except those located in Seismic Zone 1. Other related articles including the seismic design flowcharts in Appendix A3 [Figure A3-1] shall be modified accordingly.

2.07 **Temperature Range** [Article 3.12.2]. Concrete superstructures shall be designed using [Article 3.12.2.2] Procedure B with a temperature range of 60 degrees Fahrenheit with a minimum and maximum temperature of 40 and 100 degrees Fahrenheit respectively. At higher elevation areas, site specific temperature range shall be considered and coordinated with the Bridge Design Engineer.

2.08 **Shrinkage Strain** [Article 5.4.2.3.3]. Concrete shrinkage strain shall be in accordance with Equation 5.4.2.3.3-1 but not be less than 0.0003. When shrinkage-reducing admixture is specified, this value may be reduced up to 50 percent depending on the dosage and the performance strain required or specified.

2.09 **Modulus of Elasticity** [Article 5.4.2.4]. The correction factor for source of aggregate, K_1, shall be taken as 0.85 unless determined by physical test to be otherwise. For analysis of existing concrete structures, K_1 shall be taken as 1.0 unless determined by physical test.

2.10 **Control of Cracking by Distribution of Reinforcement** [Article 5.7.3.4]. Unless otherwise directed, the exposure factor used in calculating the maximum bar spacing shall be 1.00 (for Class 1 exposure condition).

2.11 **Deflection and Camber** [Article 5.7.3.6.2]. Multipliers from the latest *PCI Design Handbook* may be used for estimating deflection and camber growth for typical simple span prestressed concrete members. Consult with the local precast manufacturer for historical values if available. Excessive camber especially for full-width precast sections such as concrete tees and planks could be detrimental if the actual composite concrete topping thickness at a section is less than the required calculated thickness. Provide reasonable constraints on the plans for the maximum amount that the calculated camber can be exceeded. Be specific as to when cambers should be measured such as at release, before transporting, at delivery to project site, and after installation before concrete slab or topping is placed. State specifically the consequences if this amount is exceeded.

2.12 **Tension Stresses in Prestressed Concrete** [Article 5.9.4.2.2]. No tension stresses are allowed in the precompressed tensile zone after all losses have occurred except when computing load capacity ratings (refer to *The Manual for Bridge Evaluation*, Article 6A.5.4.1) at the design load – Inventory level. The allowable tensile stress limit in the precompressed tensile zone shall be $0.19(f_c')^{1/2}$ in ksi units.

2.13 **Shrinkage and Temperature Reinforcement** [Article 5.10.8]. This article implies that only components 6 inches or less in thickness may be placed with a single layer of reinforcing. Single layer of reinforcing shall also be permitted for components up to 10 inches thick that are not exposed to the full effects of temperature changes such as applicable components of manholes, catch basins and other buried structures. If components could be subject to extended exposure prior to being backfilled or covered, consideration shall be given to provide reinforcing on both faces.

2.14 **Concrete Cover** [Article 5.12.3]. The following changes shall be made to this article.

- Cover to ties and stirrups shall not be less than 1.5 inches except cover for stirrups in webs of precast prestressed girders may be 1.0 inch with tolerance of … -0 in. This tolerance shall be noted on the plans and/or special provisions.

- Cover for main reinforcing steel shall be in accordance with Table 5.12.3-1 and as modified herein. Cover for main reinforcing steel shall be adjusted where minimum cover for ties and stirrups govern.

- Cover for the top deck slab reinforcing steel measured perpendicular to the concrete surface shall be 2.5 inches. The *Hawaii Standard Specifications for Road and Bridge Construction* (2005) shall be modified so that footnote number 1 of Table 602.03-1 (Placement Tolerances) is not applicable for deck slabs. The footnote states, "Reduction in cover shall not exceed one-third specified concrete cover."

- Cover for the bottom layer reinforcing steel of cast-in-place or precast concrete slabs shall not be less than 1.5 inches for No. 11 bars and smaller.

- Cover for spiral ties for drilled shafts shall be 4.0 inches except for steel encased drilled shafts.

2.15 **Diaphragms** [Article 5.13.2.2]. This article is amended to require intermediate diaphragms at spacing not to exceed forty (40) feet for all girder/beam/box type structures unless tests or structural analysis show them to be unnecessary and approved by the Bridge Design Engineer.

2.16 **Sloped Footings** [Article 5.13.3.1]. Footings for walls may be sloped but not to exceed the following rates unless justification is provided:

- Reinforced concrete walls = 3 percent
- Masonry walls = 2 percent

2.17 **Shear in Footings** [Article 5.13.3.6]. Additional shear reinforcement for Seismic Zones 2, 3 and 4 shall be provided at the following locations:

- Column-type bridge footings. Vertical No. 5 bars at 12 inches spacing in each direction in a band between "d" of the footing from the face of the column and 6 inches maximum from the column reinforcement. Shear bars shall be hooked around the top and bottom reinforcement mat in the footing. The top hook shall be 135 degrees minimum and the bottom 90 degrees.

- Wall-type bridge footings including bridge abutments. Vertical No. 5 bars at 12 inches spacing in the direction perpendicular to the wall face and No. 5 bars at 24 inches spacing in the direction parallel to the wall face in the band between "d" of the footing from the face of the wall and 6 inches maximum from the column or abutment vertical reinforcement. Shear bars shall be hooked around the top and bottom reinforcement mat in the footing. The top hook shall be 135 degrees minimum and the bottom 90 degrees.

2.18 **Test Level Selection Criteria** [Article 13.7.2] for traffic railings on bridges and highway structures. Also refer to memo HWY-TD 2.2822, *Statewide Policy for Permanent Highway Safety Hardware*, dated March 1, 1999 including any subsequent revisions or updates. This policy document shall govern if there are any legal conflicts with Test Level designations and requirements stated herein. Unless otherwise directed, all traffic railings on bridges and highway structures shall conform to the following test levels:

- TL-1 (Test Level One) – For low speed areas with design speed of 30 mph or less.

- TL-2 (Test Level Two) – For design speed of 45 mph or less, or for posted speed of 35 mph or less.

- TL-3 (Test Level Three) and TL-4 (Test Level Four) – For design speed greater than 45 mph, or for posted speed greater than 35 mph.

- TL-5 (Test Level Five) – For barriers used to protect bridge piers/columns and abutments. For design of bridge piers/columns and abutments for vehicular collision, see Article 3.6.5.1.

Unless otherwise exempted, all traffic railings on the National Highway System shall conform to TL-3 minimum.

2.19 **Geometry** [Article 13.8.1] for pedestrian railings. The maximum clear opening between horizontal and/or vertical elements for the lower 27 inches of the railing shall be 4 inches instead of the specified 6 inches diameter sphere clearance criteria unless otherwise approved by the Bridge Design Engineer.

2.20 **Cement Rubble Masonry (CRM) or Stone Masonry Walls**. The *AASHTO LRFD Bridge Design Specifications* does not include design for these walls. CRM walls may be used for retaining as well as barrier structures. However, they shall not be used to support a new or replacement bridge. Minimum thickness for CRM walls shall be 16 inches.

Unreinforced CRM walls may be designed for the following allowable stresses using unfactored loads:

- Compressive Stress (Under any loading condition) = 100 psi
- Tensile Stress (Under sustained loads only) = 0 psi
- Tensile Stress (With extreme event loads) = 10 psi

3.0 MODIFICATIONS TO *AASHTO GUIDE SPECIFICATION FOR LRFD SEISMIC BRIDGE DESIGN*

3.01 **Applicability of Guide Specifications** [Article 3.1]. This Guide Specifications apply to conventional bridges only. It does not address critical or essential bridges. Except for temporary bridges, all new or replacement bridges shall be classified as essential. Essential bridges shall be designed for an earthquake with a 1,500-year return period. Temporary bridges may be designed for an earthquake with a 10-year or 50-year return period as determined by the Bridge Design Engineer.

3.02 **Design Requirements for Single-Span Bridges** [Article 4.5]. This article shall be amended to require seismic analysis for all bridges except those located in Seismic Design Category A. Other related articles including the Flow Charts in Article 1.3 shall be modified accordingly. Pushover analysis is not required for single-span bridges.

3.03 **Shear in Footings**. In addition to the guide specifications requirements, additional shear reinforcement for Seismic Design Categories B, C and D shall be provided at the following locations:

- Column-type bridge footings. Vertical No. 5 bars at 12 inches spacing in each direction in a band between "d" of the footing from the face of the column and 6 inches maximum from the column reinforcement. Shear bars shall be hooked around the top and bottom reinforcement mat in the footing. The top hook shall be 135 degrees minimum and the bottom 90 degrees.

- Wall-type bridge footings including bridge abutments. Vertical No. 5 bars at 12 inches spacing in the direction perpendicular to the wall face and No. 5 bars at 24 inches spacing in the direction parallel to the wall face in the band between "d" of the footing from the face of the wall and 6 inches maximum from the column or abutment vertical reinforcement. Shear bars shall be hooked around the top and bottom reinforcement mat in the footing. The top hook shall be 135 degrees minimum and the bottom 90 degrees.

4.0 MODIFICATIONS TO AASHTO *STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS*

Note: For manufacturer designed support structures, all affected design parameters contained herein shall be noted on the construction plans.

4.01 **Basic Wind Speed** [Article 3.8.2] to determine the design wind pressure shall be 105 mph. For unusual or differing exposure conditions, the basic wind speed should be increased using rational procedures and sound engineering judgment. Alternatively, the design wind pressure may be increased by using a higher Wind Importance Factor [Table 3.8.3-1] corresponding to a recurrence interval of at least one level greater than recommended. The wind maps for Effective Wind Speed, Topographic Effects and Exposure Category included in the State Building Code (Hawaii Administrative Rules, Chapter 3-180) should be used for guidance.

4.02 **Wind Importance Factors** [Table 3.8.3-1] and **Velocity Conversion Factors** [Table 3.8.3-3] used to determine the design wind pressures shall be based on the following recurrence intervals:

- For overhead sign structures: 100 years
- For traffic signal structures: 50 years
- For luminaire support structures less than 50 feet in height: 25 years
- For other support structures including luminaire support structures 50 feet or more in height, and when luminaire is mounted on a traffic signal structure: 50 years
- For roadside sign structures & temporary support structures: 10 years

4.03 **Height and Exposure Factor** [Article 3.8.4]. For support structures on bridges, the height and exposure factor shall be determined based on the maximum height they are above the surrounding ground. For severe exposure conditions such as along the coastline, the factor shall be increased based on the latest ASCE Standard ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures*. The wind maps for Effective Wind Speed, Topographic Effects and Exposure Category included in the State Building Code (Hawaii Administrative Rules, Chapter 3-180) should also be used for guidance.

4.04 **Minimum Anchor Bolts** [Article 5.17.3]. Cantilevered traffic signal structures with mast arms greater than 40 feet and other cantilevered support structures with design life of 50 year or more shall have base plate connections with a minimum of six (6) anchor bolts. A minimum of four (4) anchor bolts shall be provided for all other base plate connections.

4.05 **Use of Grout** [Article 5.17.3.3]. Grout shall not be used under base plates for all support structures except for ordinary street light poles unless approved by the Bridge Design Engineer. Anchor bolts with leveling nuts shall be designed to transfer all loads from the structure to its base support.

A wire cloth screen shall be specified to be placed vertically between the base plate and the top of the foundation and wrapped horizontally around the base plate with a 3 inches minimum lap. The wire cloth shall be galvanized steel standard grade plain weave 2x2 mesh 0.063 inch diameter wires. The screen shall be attached to the base plate with stainless steel self-tapping ¼ inch diameter screws with stainless steel washers spaced at 9 inches on centers. Also, alternate means of protecting the underside of the base plate from debris, birds, bees and other nesting animals may be proposed for consideration.

4.06 **Plumbness of Anchor Bolts** [Article 5.17.5.3]. The designer shall include this provision of the design specification in the construction plans and/or specifications.

"Anchor bolts shall be installed with misalignments of less than 1:40 from vertical. After installation, firm contact shall exist between the anchor bolt nuts, washers, and base plate on any anchor bolt installed in a misaligned position."

4.07 **Fatigue Importance Factors** [Article 11.6] noted in Table 11.6-1 for overhead sign and traffic signal structures shall be based on Fatigue Category I.

Support structures other than that noted in Table 11.6-1 with round cross sections under 50 feet, roadside sign structures, and temporary structures do not need to be designed for fatigue.

Support structures 50 feet or more in height shall be designed for fatigue and be based on Fatigue Category I.

4.08 **Galloping** [Article 11.7.1.1]. Provisions shall be made to install effective vibration mitigation devices on overhead cantilevered sign and traffic signal support structures unless they are designed for galloping-induced cyclic loads. With approval from HDOT, mitigation devices may be installed after construction if vibration due to galloping is identified. Responsible party for the mitigation devices shall be determined during design and included in the construction documents.

4.09 **Natural Wind Gust** [Article 11.7.1.2]. Overhead sign, traffic signal, and high-level support structures shall be designed to resist an equivalent static natural wind gust pressure. For unusual or differing exposure conditions, the equivalent static natural wind gust pressure should be increased using references noted in the specifications.

4.10 **Truck-Induced Gust** [Article 11.7.1.3]. Overhead sign and traffic signal support structures shall be designed to resist an equivalent static truck gust pressure range based on a truck speed of 20 mph over the posted speed.

4.11 **Square or Rectangular Steel Post Sections** [Sections 5 and 11]. Square or rectangular steel sections are not recommended to be used for overhead sign and traffic signal supports because they are more prone to poor fatigue performance. However, the post sections contained in the Highways Division *Standard Plans* (2008) for overhead sign structures (Standard Plans TE-17A through TE-19M) shall be considered acceptable and may still be used. Any special designs or deviations from the *Standard Plans* shall be coordinated with the Bridge Design Engineer.

5.0 MODIFICATIONS TO AASHTO *THE MANUAL FOR BRIDGE EVALUATION* (Section 6, Part A – Load and Resistance Factor Rating)

5.01 **Dead Loads** [Article 6A.2.2.1]. Unit weight of concrete (normal) as noted in Table 3.5.1-1 of the *AASHTO LRFD Bridge Design Specifications* shall be 160 pcf. Use 150 pcf for the determination of the modulus of elasticity.

5.02 **Vehicular Live Loads (Gravity Loads): LL** [Article 6A.2.3.1]. Modify Permit Loads to include:

- Actual Permit Truck; or
- Hawaii Standard Single Trip Permit Vehicles as modified in Section 5.06 for Article 6A.4.5.4.1.

5.03 **Dynamic Load Allowance: IM** [Articles 6A.2.3.3, 6A.4.3.3, 6A.4.4.3, and 6A.4.5.5]. Articles 6A.4.3.3, 6A.4.4.3, and 6A.4.5.5 shall be deleted. Article 6A.2.3.3 shall be replaced with the following:

The dynamic load allowance for evaluation shall be as specified in Table 6A.2.3.3-1.

Table 6A.2.3.3-1 – Dynamic Load Allowance

Loading Type	Riding Surface Conditions	Dynamic Load Allowance (IM)	
		Spans ≤ 40 feet	Spans > 40 feet
Design Loads:	3	33%	33%
	2	33%	33%
	1	33%	33%
Legal Loads:	3	33%	10%
	2	33%	20%
	1	33%	33%
Permit Loads:	3	33%	10%
	2	33%	20%
	1	33%	33%

Dynamic load allowance need not be applied to lane loads at the Design and Legal Load Rating and to wood components (LRFD Design Article 3.6.2.3).

Riding surface conditions shall be selected based on field observations and judgment of the inspector during bridge inspections. Riding surface conditions shall be defined as follows: 3 – smooth riding surface at approaches, bridge deck, and expansion joints; 2 – minor surface deviations or depressions; and 1 – approach and bridge deck conditions with bumps, sags, or other major surface deviations and discontinuities.

The dynamic load allowance may be eliminated for slow moving (≤ 10 mph) permit vehicles.

5.04 **Condition Factor: φ_c** [Article 6A.4.2.3]. Replace Table 6A.4.2.3-1 with the following table and comments:

Table 6A.4.2.3-1 – Condition Factor: φ_c

Superstructure Condition Rating (SI & A Item 59)	Equivalent Member Structural Condition	φ_c
6 or higher	Good or Satisfactory	1.00
5	Fair	0.95
4 or lower	Poor	0.85

If section properties are obtained accurately, by actual field measurements of losses rather than by an estimated percentage of losses, the values specified for φ_c in Table 6A.4.2.3-1 may be increased by 0.05 ($\varphi_c \leq 1.0$).

5.05 **System Factor: φ_s** [Article 6A.4.2.4]. Replace Table 6A.4.2.4-1 with the following table:

Table 6A.4.2.4-1 – System Factor: φ_s for Flexural and Axial Effects

Superstructure Type	φ_s
Welded Members in Two-Girder/Truss/Arch Bridges	0.85
Riveted Members in Two-Girder/Truss/Arch Bridges	0.90
Multiple Eyebar Members in Truss Bridges	0.90
All Other Girder Bridges and Slab Bridges	1.00
Floorbeams with Spacing > 12 ft. and Noncontinuous Stringers	0.85
Redundant Stringer Subsystems between Floorbeams	1.00

Definitions:
Floorbeam – A horizontal flexural member located transversely to the bridge alignment.
Girder – A large flexural member, usually built-up, which is the main or primary support for the structure, and which usually receives load from floorbeams, stringers, or directly from the deck.
Stringer – A longitudinal beam supporting the bridge deck.

5.06 **Live Load** [Article 6A.4.5.4.1]. Add the following to the beginning of Article 6A.4.5.4.1:

The Hawaii Standard Single Trip Permit Vehicles shown in Figure 6A.4.5.4.1-1, Figure 6A.4.5.4.1-2, and Figure 6A.4.5.4.1-3 shall be used for permit load rating. A single trip overweight permit load analysis assumes only one permit load on the bridge, which allows the use of the single-lane distribution factor. When using the single-lane LRFD distribution factor, the 1.2 multiple presence factor shall be divided out from the distribution factor equations. For girder bridges, the interior and exterior girders shall be checked to see which governs. For single trip permit vehicles, it is important to note that the vehicle could traverse the bridge in any lane, making it necessary to investigate whether the exterior girder controls the load rating.

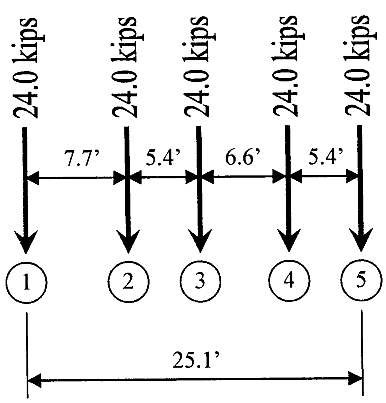

Figure 6A.4.5.4.1-1 – Hawaii Standard Single Trip Permit Vehicle – HP1 (120.0 kips)

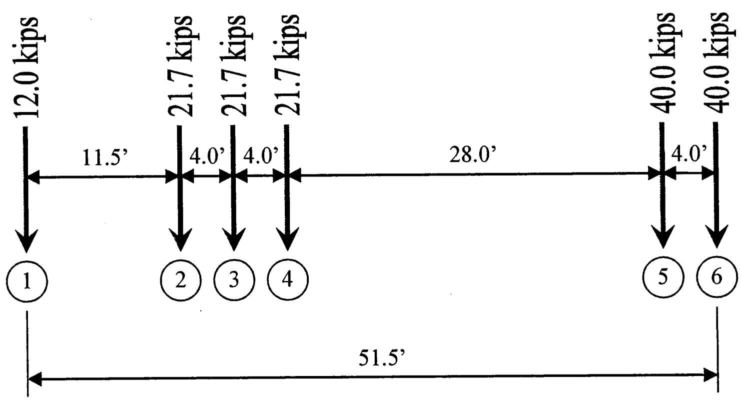

Figure 6A.4.5.4.1-2 – Hawaii Standard Single Trip Permit Vehicle – HP2 (157.0 kips)

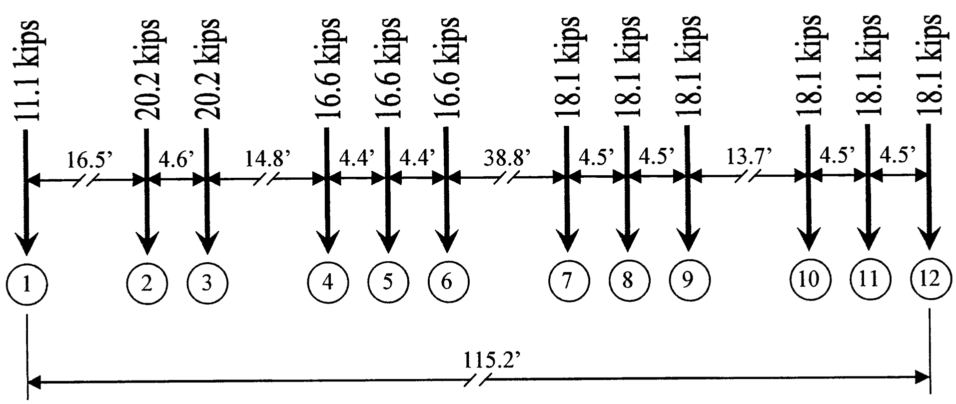

Figure 6A.4.5.4.1-3 – Hawaii Standard Single Trip Permit Vehicle – HP3 (209.9 kips)

5.07 **Routine (Annual) Permits** [Article 6A.4.5.4.2a]. Replace Table 6A.4.5.4.2a-1 with the following table:

Table 6A.4.5.4.2a-1 – Permit Load Factors: γ_L

Permit Type	ADTT	Permit Load Factor
Permit Type – Continuous operation, all structures except Reinforced Concrete Box Culverts Loading Condition – Mixed with normal traffic LRFD Distribution Factor – Two or more lanes	> 5000	1.40 [a]
	≤ 1000	1.35 [a]
Permit Type – Continuous operation, Reinforced Concrete Box Culverts only Loading Condition – Mixed with normal traffic LRFD Distribution Factor – One lane	All ADTT's	1.40 [b]
Permit Type – Single trip Loading Condition – Escorted with no other vehicles on the bridge LRFD Distribution Factor – One lane	n/a	1.10 [b]
Permit Type – Single trip Loading Condition – Mixed with normal traffic LRFD Distribution Factor – One lane	All ADTT's	1.20 [b]

Notes:

[a] Linear interpolation is permitted for ADTT values between 1000 and 5000.

[b] When one-lane distribution factor is used, the built-in multiple presence factor should be divided out.

5.08 **Legal Load Rating** [Article 6A.5.4.2.2a]. Replace with the following: Load rating of prestressed concrete bridges based on satisfying limiting concrete tensile stresses under service loads at the Service III limit state is not required, except for segmentally constructed bridges. A live load factor of 1.0 is recommended for legal loads when using this check for rating purposes.

5.09 **Permit Load Rating** [Article 6A.5.4.2.2b]. Replace with the following: The provisions of this article are not required.

5.10 **Dead Loads** [Article 6A.5.12.10.1]. Unit weight of concrete (normal) as noted in Table 3.5.1-1 of the *AASHTO LRFD Bridge Design Specifications* shall be 160 pcf. Use 150 pcf for the determination of the modulus of elasticity.

5.11 **Vertical Earth Pressure: EV** [Article 6A.5.12.10.2a]. Unit weight of compacted earth shall be 120 pcf minimum.

5.12 **Lateral Earth Pressure: EH** [Article 6A.5.12.10.2b]. A lateral earth pressure of 45 pcf shall be used. However, a higher value may be used based on knowledge of actual existing condition.

6.0 ADDITIONAL GUIDELINES

6.01 **Approach Slabs.** Approach slabs shall be provided on all new bridges unless otherwise directed. If an existing bridge is being widened and it has an approach slab, it shall be provided at the widened portion as a minimum. If the existing bridge does not have an approach slab, consideration should be given to provide one if conditions justify it.

- Length of approach slab shall be such that influence of live loads on the slab does not impose lateral earth pressure on the abutments. A Geotechnical Engineer, a consultant or HDOT Material Testing and Research Branch, shall determine the length.

- Slabs shall be designed to span simply supported. Center of support at approach end shall be based on centerline of bearing of thickened edge. Width of thickened edge shall be determined based on the given soil parameters.

6.02 **Design of Covers for Junction Boxes, Handholes, Gaps, Holes, or Cavities ("Boxes") in Concrete Guardrails.**

- It is preferred that all "boxes" be located on the opposite side of the traffic face of concrete guardrails.

- If not possible to locate on opposite side, then try to locate "boxes" above the minimum guardrail height but not less than 32 inches above the roadway or shoulder surface.

- If the "boxes" must be located under 32 inches or under the minimum guardrail height, then the covers for the "boxes" shall be designed for a linear transverse force acting parallel to the roadway surface and applied anywhere along the vertical face of the cover. The minimum linear load shall be as follows:

  - For TL-1: 4 klf (13.5 kips maximum total)
  - For TL-2: 8 klf (27 kips maximum total)
  - For TL-3 & TL-4: 16 klf (54 kips maximum total)
  - For TL-5: 36 klf (124 kips maximum total)

- The concrete guardrail around the "boxes" shall be appropriately designed to account for their presence.

- The above design loads are not in-lieu of any wheel loads that may be applied to the covers for the "boxes". The covers shall also be designed for wheel loads and wheel impact if applicable.

6.03 **Design Live Load for Grade Structures Located off Roadway and Shoulders.** Manholes, handholes, catch basins, grated drop inlets, culverts, and other grade structures within HDOT's right-of-way shall be designed for a minimum wheel load of 16 kips (unfactored). If grade structures are large enough to accommodate multiple wheel loads, then the design shall account for the additional wheels. Any exception to this requirement shall be approved by the Bridge Design Engineer.

6.04 **Concrete Fillets for Culverts and Box Girders.**

- Concrete box culverts. Fillets are required at the top corners unless top slab is precasted or designed accordingly. Bottom fillets are recommended if water will "sit" for an extended period of time at the wall construction joint. Otherwise, bottom fillets are optional.

- Concrete box girders. Bottom fillets of girder stems for concrete box girders are optional unless required to satisfy stresses by design. If bottom fillets are shown on the plans, a note should be added that they are not required by design. Top fillets for girder stems are required.

6.05 **Load Capacity Ratings** for all bridges shall be in accordance with *The Manual for Bridge Evaluation*, (Section 6, Part A – Load and Resistance Factor Rating) and as modified herein.

- BRASS (Bridge Rating and Analysis of Structural Systems), a software maintained by the Wyoming Department of Transportation, shall be the primary load rating software for rating of concrete, steel, and timber girder bridges as well as culverts using the LRFR methodology. Version of BRASS-GIRDER (LRFD) to be used shall be approved by the Bridge Design Section. Alternative software may be used for analyzing and rating truss or arch bridges.

- A BRASS input file for the bridge being rated shall be submitted as part of the load rating deliverables. The following load models shall be defined in the BRASS input file for each structure rated: HL-93, Type 3, Type 3S2, Type 3-3, NRL, SU4, SU5, SU6, SU7, HP1, HP2, and HP3. The Bridge Load Rating Summary Sheet is shown in Appendix B. A completed summary sheet shall be submitted for each bridge that is load rated. An electronic version of the summary sheet may be obtained from the Bridge Design Section.

- For new and rehabilitated bridges, the inventory and operating load ratings for the HL-93 design vehicle including live load distribution factors for the controlling member(s) shall be shown on the drawings with the structural notes for future reference.

6.06 **Vertical Clearances for Separation Structures.**

- Over Interstate Highways. 16'-6" minimum over the entire roadway width including the usable width of the shoulders.

- Over Other State Highways. 15'-6" minimum over the entire roadway width including the usable width of the shoulders.

- Under Overhead Sign Structures and Light Fixtures. Clearance shall be a minimum of one foot greater than specified for the above conditions.

- Under Pedestrian Bridges. 17'-6" minimum over the entire roadway width including the usable width of the shoulders.

- For resurfacing projects under an existing bridge, the clearance shall be verified. If the clearance will be less than the minimum required vertical clearance, the existing clearances shall be maintained or improved.

- For clearances under construction falsework, forms and shoring, the minimum noted above for Interstate and Other State Highways shall be maintained.

6.07 **Bridge Endposts/Guardrail Transitions – Trailing End on Divided Highways.**

- For fill slopes at trailing end of bridges greater than 3H:1V, provide guardrail transition similar to approach end unless otherwise directed.

- For fill slopes at trailing end of bridges equal to or less than 3H:1V, no guardrail transition required at trailing end unless an obstruction or obstacle occurs within 25'-0" from the end of the bridge within the minimum recommended clear zone.

- For cut slopes at trailing end of bridges, decision for guardrail requirement shall be based on likelihood of impact and site specific circumstances.

6.08 **Seismic Retrofitting of Existing Bridges**. Unless otherwise directed, procedures for designs for seismic retrofitting of existing bridges shall be in accordance with Caltrans *Earthquake Retrofit Guidelines for Bridges*. In addition FHWA publication *Seismic Retrofitting Manual for Highway Structures: Part 1 - Bridges*, FHWA-HRT-06-032, January 2006, may be referenced for supplemental information.

6.09 **Design of Overhead Sign Structures.** In addition to design requirements contained in the latest *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and as modified herein, design of overhead sign structures shall consider the following:

- Design shall be such that structure can be inspected without executing unusual procedures. Design shall be coordinated with the applicable HDOT District Office responsible for its maintenance and inspections.

- Lights for illuminating signs, if required, should be serviceable.

- Members used for anchor points for fall protection equipment shall be designed for a minimum load of 5,000 lbs. in accordance with OSHA regulations.

6.10 **Retrofitting of Existing Overhead Sign Structures.** The retrofitting philosophy shall be "no collapse". Retrofitting of existing footings or other items that may have an impact on traffic should be minimized. Any item whose failure may be a safety concern shall be upgraded and designed in accordance with the latest *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and as modified herein.

6.11 **Falsework Design.**

- Falsework traffic openings (widths and heights), if required, shall be indicated on the plans and in the specifications.

- Design of falsework shall consider any increased or readjusted loads caused by prestressing, post-tensioning, or secondary forces imposed during construction. The design engineer shall indicate these loads on the plans.

6.12 **Anchorages/Connections to Existing Concrete.** This provision applies to attachments (such as for utility lines/conduits, miscellaneous signs, or hardware) to existing bridges and highway structures. If installation involves drilling into existing concrete, existing reinforcing bars shall not be damaged. All embedded anchors including reinforcing steel dowels shall be embedded with epoxy including expansion or wedge type anchors. Epoxy shall be low-creep type designed for use under sustained direct tension. Anchorages except for those that will be encased in concrete with required cover shall be corrosion resistant, Type 316 stainless steel or better. All abandoned drilled holes shall be filled with an approved non-shrink grout or epoxy grout. Existing reinforcing bars shall not be damaged. Drilling into prestressed concrete members is not permitted except for special circumstances with the approval of the Bridge Design Engineer. Details and appropriate notes shall be provided on the drawings.

7.0 QUALITY CONTROL AND QUALITY ASSURANCE PROGRAM FOR DESIGN OF BRIDGES AND STRUCTURES

This Section establishes the minimum requirements for the Quality Control (QC) and Quality Assurance (QA) for the design of bridges and structures for HDOT.

In August 2011, FHWA prepared a document and reviewed by AASHTO entitled "Guidance on Quality Control and Quality Assurance (QC/QA) in Bridge Design". This guidance was prepared in response to National Transportation Safety Board recommendation H-08-17 as a result of the investigation conducted after the collapse of the I-35W highway bridge over the Mississippi River in Minneapolis, Minnesota on August 1, 2007. The guidance states:

> *A QC/QA program establishes the formal office or organizational procedures or practices for ensuring the owner's requirements and expectations are fully met. A QC/QA program provides checks and balances within an organization to assure quality in the final contract plans and specifications. QC/QA programs are implemented at different levels or phases of project activities. In the design phase, the bridge designer is responsible for making sure his/her calculations and drawings are accurate and meeting the requirements of the design. The bridge designer performs QC of his/her own work by establishing a procedure for self-checking the work for accuracy and correctness. On the other hand, the reviewer, practicing QA, is responsible for independently checking the work of the bridge designer to assure accuracy and correctness in meeting the design requirements and expectations of the bridge owner. In construction, QC is the responsibility of contractor to ensure the quality of the work is carried out in compliance with the contract provisions. On the other hand, the owner is responsible for practicing QA to assure that the contractor is carrying the work in accordance with the contract.*

The FHWA guide document should be referenced for clarification of the intent of the QC/QA program and to assist structural design consultants and their team in establishing their programs.

The procedures and guidelines provided herein are applicable to ordinary conventional types of bridges and structures. Additional QC/QA procedures may be required for the design of complex and unusual structures such as suspension bridges, cable-stayed bridges, etc.

7.01 **Definition of Terms.**

Quality Control (QC). Procedures of checking the accuracy of the calculations and consistency of the drawings, detecting and correcting design omissions and errors before the design plans are finalized, and verifying the specifications for the load-carrying members are adequate for the service and operation loads.

Quality Assurance (QA). Procedures of reviewing the work to ensure the quality control are in place and effective in preventing mistakes, and consistency in the development of design plans and specifications for bridges and structures.

Designer. An individual directly responsible for the development of design calculations, drawings, specifications, special provisions, estimates, and other contract documents and review of shop drawings related to a specific bridge or structure design. The designer shall be a Licensed Structural Engineer (SE), or under the direct supervision of an SE. (If the design is performed in-house by HDOT, the designer may be an SE or Licensed Civil Engineer (CE), or under the direct supervision of an SE or CE.) He/she shall be experienced in structural designs and familiar with HDOT's "Design Criteria for Bridges and Structures". The designer and/or the direct supervisor shall possess a level of technical skills and experience commensurate with the complexity of the bridges or structures being designed.

Checker. An individual responsible for performing a full technical review of the structural design calculations, drawings, specifications, special provisions, estimates, and other contract documents. The checker shall perform sufficient independent design checks to assure the adequacy of the design. The checker shall be an SE other than the designer or the supervising SE of the designer. (For in-house HDOT designs, the checker shall be an SE or CE other than the designer or the supervising engineer of the designer.) He/she shall be experienced in structural designs and familiar with HDOT's "Design Criteria for Bridges and Structures". The checker's knowledge and experience shall be commensurate with the complexity of the bridge or structures being designed. For complex or unusual bridges and structures, the checker may be required to be from a consulting firm other than that of the designer.

Technician. A drafter or engineer who generates and revises details, plan sheets, and drawings in electronic format.

Reviewer. An individual responsible for performing QA procedures for assuring that QA procedures have been performed. The reviewer should be an SE. He/she should be familiar with HDOT's design criteria, construction practices, procedures, and policies.

Engineer-of-Record (EOR). An individual responsible for all structural aspects of the design of the bridge or structure including the design of all of the structural systems and components. The EOR shall be a Hawaii Licensed Structural Engineer. Except for in-house designs by HDOT, the final contract plans and structural calculations shall be sealed and signed by the EOR.

7.02 QC/QA Procedures for Consultant Designed Projects.

- All consultants performing design of bridges and structures for HDOT shall have a documented QA program for its design, which shall include QC measures. This shall apply to the firm of the EOR and any and all of its subconsultants. If their subconsultants do not have their own documented QC/QA program, the EOR shall assume that responsibility. The QC/QA program shall detail the procedures, standards, and policies to be used in the oversight of the bridge or structure design. The program documentation shall be furnished to HDOT upon request.

- A qualified checker shall thoroughly review all design calculations, drawings, specifications, special provisions, estimates, and other contract documents. All sheets of the structural calculations and drawings shall be initialed and dated by the checker along with that of the designer. This review shall be conducted prior to each submittal to HDOT unless otherwise approved by the Bridge Design Engineer. See Figures 7.1 and 7.2 for Flowcharts for the Review Processes for Calculations and Drawings, respectively. The review process for other contract documents should be similar to the review process for calculations. There shall be no waiver of this requirement for final contract document submittals for construction. Failure to do this will be grounds for rejection and no review will be conducted by the Bridge Design Section until this criteria is met. No extension of design time will be allowed for noncompliance.

- HDOT's role in the QA process shall be as a reviewer. It shall be understood that HDOT's reviewer is only required to perform reviews for general conformance of the design to the established design criteria as specified in the consultant's contract agreement. The reviewer may conduct a cursory check of the construction documents to assist in the review process but in no way shall it be considered an in-depth and thorough review. All review comments shall be addressed by the designer and incorporated in the next submittal unless it is mutually agreed that the comment is not applicable. Under no circumstance does a QA review by HDOT release the consultant from their contractual responsibilities involving QC/QA or from professional liability involving the engineering, plans, specifications/special provisions, quantities and cost estimates, or from recovery of damages that result from errors and omissions in the construction documents.

7.03 **QC/QA Procedures for Design-Build Projects.**

- The Design-Build (DB) Contractor shall have a documented QC/QA program for the entire DB team. The DB Contractor shall be fully responsible for the work of all the design subconsultants unless terms of their agreement say otherwise. All final structural plans and calculations shall be sealed and signed by the EOR. The QC/QA program shall detail the procedures, standards, and policies to be used in the oversight of the bridge or structure design. The program documentation shall be furnished to HDOT during the procurement process, as applicable, and finalized after selection of the DB Contractor.

- HDOT's role in the QA process may be as a reviewer. It shall be understood that HDOT's reviewer is only required to perform reviews for general conformance of the design to the established design criteria as specified in the Request for Proposal unless otherwise modified. The reviewer may conduct a cursory check of the construction documents to assist in the review process but in no way shall it be considered an in-depth and thorough review. All review comments shall be addressed by the designer and incorporated in the next submittal unless it is mutually agreed that the comment is not applicable. Under no circumstance does a QA review by HDOT release the DB Contractor and/or the EOR from their contractual responsibilities involving QC/QA or from professional liability involving the engineering, plans, specifications/special provisions, quantities and cost estimates, or from recovery of damages that result from errors and omissions in the construction documents.

7.04 **QC/QA Procedures for In-House Designed Projects.**

- All designs of bridges and structures performed by engineers within the Bridge Design Section of HDOT shall be conducted by or under the supervision of the Unit Supervisor. The designer shall review the drawings to ensure that they are in conformance with the design. The Unit Supervisor shall review all work of the designer including checking of the design calculations, drawings, specifications, special provisions, and estimates. The review process for calculations and drawings shall be similar to that outlined in Figures 7.1 and 7.2, respectively. The review process for other contract documents should be similar to the review process for calculations.

- In addition, all designs of bridges and structures shall be reviewed by a qualified Licensed Civil or Structural Engineer other than the designer or the Unit Supervisor.

- All pertinent review comments/resolutions shall be retained in the permanent bridge design file. All check sets of drawings shall be initialed by the technician, the drawing checker, the designer, the design checker, and the reviewer, as applicable. All calculations shall be initialed by the designer and the checker/reviewer.

7.05 **QC/QA Procedures for Addendums, Change Orders and other Design Changes.**

- Procedures for addendums and change orders during the design phase shall be similar to Sections 7.02 and 7.04, as applicable.

- Procedures for design changes during the construction phase conducted by the design consultant for HDOT or the Bridge Design Section shall be similar to Sections 7.02 and 7.04, respectively.

- Procedures for design changes during the construction phase proposed by the construction contractor including any remedial action requiring structural engineering and conducted by his design consultant shall be similar to Section 7.03.

7.06 **Required Submittals for Consultant Designed and Design-Build Bridges and Structures.**

In addition to the submittal requirements written in the contract agreement with HDOT, the following items in its final form shall be submitted to the Bridge Design Section for archiving purposes:

- Final design calculations for all structural items including bridges, buildings, retaining walls, culverts, manholes, sign structures, etc. as noted in Appendix A, REQUIREMENTS FOR CONSULTANT DESIGNED STRUCTURAL CALCULATION SUBMITTALS.

- Final construction plans and specifications/special provisions.

- Inventory and Operating Load Ratings for all bridges including BRASS input data files, as applicable.

- All reports, e.g. basis of designs, engineering reports, geotechnical reports, etc.

7.07 **Record Retention.**

- All bridge and structure calculations, plans and applicable specifications/special provisions shall be retained permanently by the Bridge Design Section. At the discretion of the Bridge Design Engineer, past records of bridges and structures that have been replaced or demolished may be destroyed.

- Load ratings calculations for each bridge shall be retained at least for the life of the bridge or until new load ratings supersede those previously calculated.

- All other reports may be destroyed after 10 years with the approval of the Bridge Design Engineer.

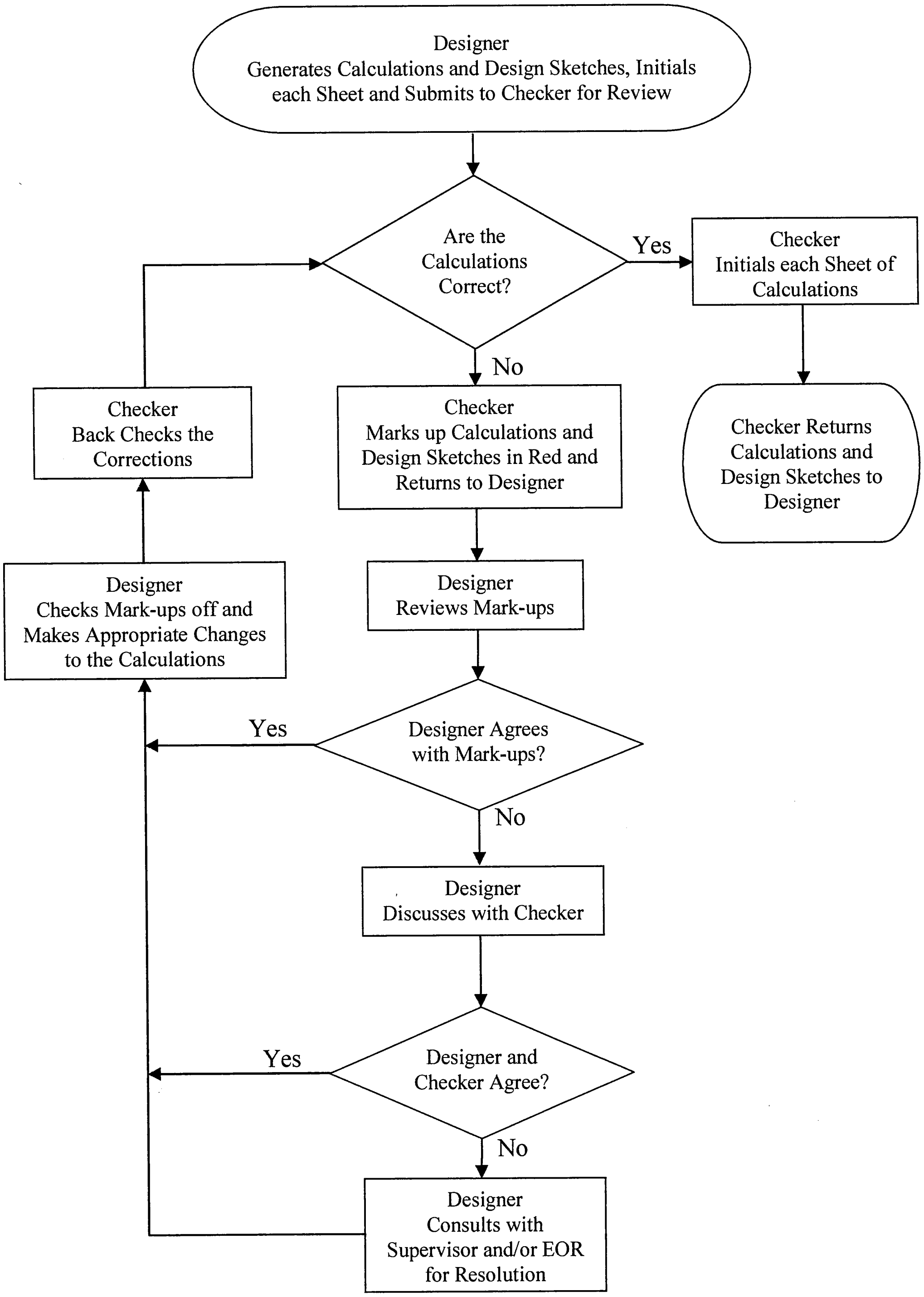

Figure 7.1: Flowchart for Review Process for Calculations

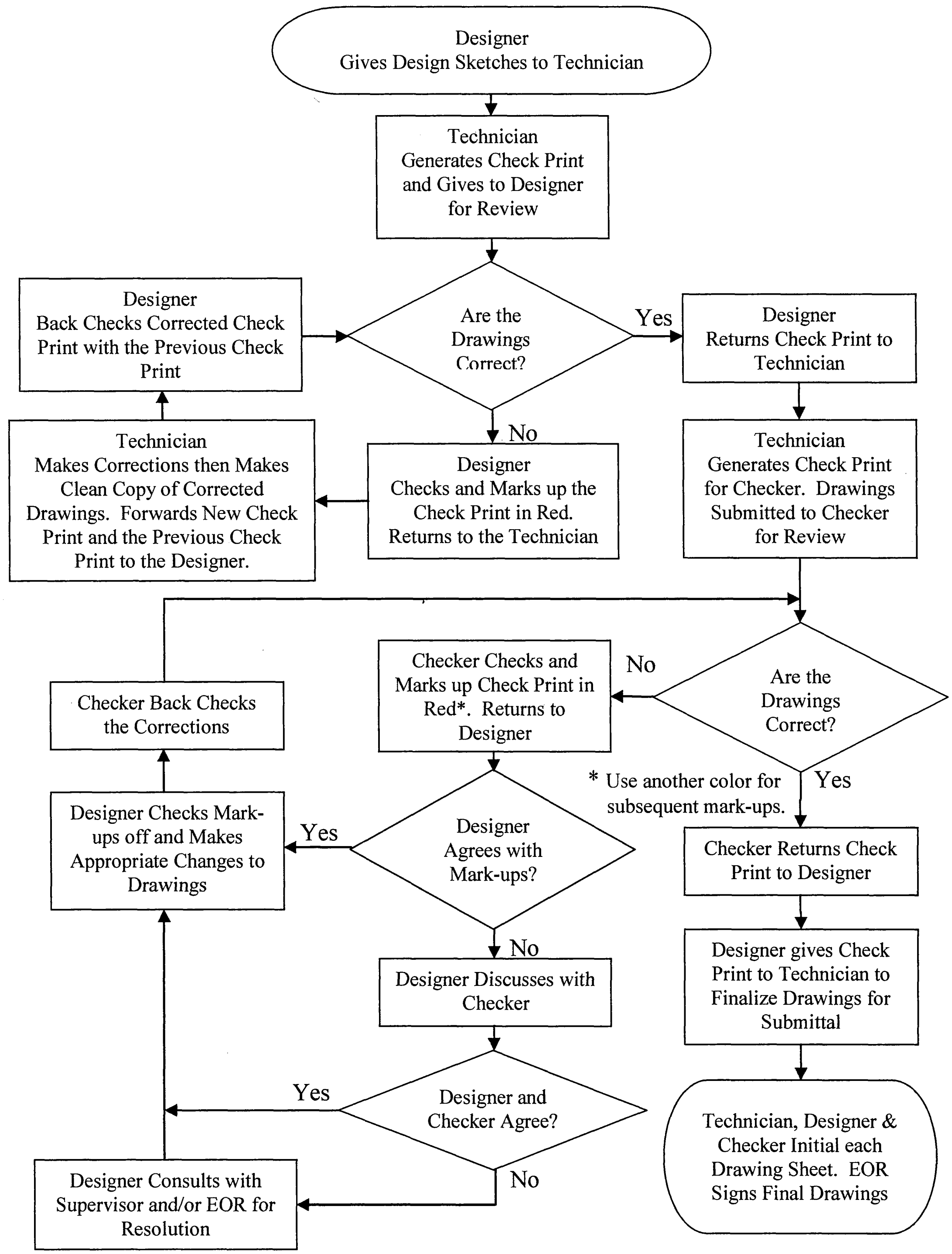

Figure 7.2: Flowchart for Review Process for Drawings

APPENDIX A

REQUIREMENTS FOR CONSULTANT DESIGNED STRUCTURAL CALCULATION SUBMITTALS

A. Calculations shall be stamped and signed by a Hawaii Licensed Structural Engineer.

B. All calculations shall have "DESIGNED BY" and "CHECKED BY" boxes with appropriate initials/signatures and dates.

C. Provide hard copies and PDF files of all structural calculations, geotechnical reports, and hydraulics reports.

D. There shall be a Table of Contents for the set of calculations included in each volume if the calculations are in more than one volume. The Table of Contents for the set shall list what each volume of the set contains. In addition there shall be a more detailed Table of Contents for each volume which contains a more detailed explanation of what that volume contains. All sheets shall be numbered by volume and page.

E. All structural calculations shall either be checked by the Licensed Structural Engineer stamping and signing the calculations or by another Licensed Structural Engineer if the Licensed Structural Engineer stamping and signing the calculations is also the designer. Also refer to Sections 7.02 and 7.03.

F. Summary sheets shall be contained in each volume of the structural calculations and shall include as a minimum:

1. The design methodology and basis of design.

   a. Exceptions to the design methodology and basis of design used in the Structural calculations.

   b. The peak horizontal ground seismic acceleration coefficient and seismic response spectra used in the structural calculations. The applicable parameters used to define the design earthquake shall be noted on the structural drawings.

   c. All applicable wind factors used in the structural calculations including but not limited to; importance factors, wind speed, height, truck gust speeds, fatigue level for connections, etc.

   d. Tsunami run up height, design flood levels, water velocities and other applicable hydraulic factors used in the structural calculations.

   e. Vehicle collision test level. Design force for any applicable vehicle or vessel collision on the structure.

   f. Scour depth(s) considered in the design.

g. Any other transient load parameters used in the design.

2. Structural material properties and specifications for each and all elements in the design. In addition the summary sheet shall include:

   a. Any exceptions to structural material properties.

   b. A detailed explanation of any non-typical structural materials and their assumed properties and method of testing.

3. Geotechnical material properties and specifications including:

   a. References to the Geotechnical Report including the date of the report. For large projects the designer shall reference specific sections or pages in the Geotechnical Report where soil properties are taken from (for example: soil spring constants, soil pressures, etc.)

   b. Any assumed geotechnical properties not given in the Geotechnical Report including the reason and/or reference for the assumptions.

4. A summary of existing conditions and any findings.

5. A summary of all special construction requirements.

6. A list of all computer programs used in the calculations.

7. A sketch or picture of all bridge or structural models used, showing elements, nodes, springs, points of fixity, etc. used in the final structural models.

8. A summary of all design alternatives considered including the justification for their exclusion and a justification for the chosen alternative.

G. Structural Calculations

1. The structural calculations shall be divided by structure with the name of the structure and location and shall include:

   a. A summary of the type of structure (e.g. precast plank bridge, cantilever retaining wall, etc.).

   b. Structural calculations shall be further divided by individual structural elements being analyzed/designed and shall include:

      1) A summary of input parameters for spreadsheets or proprietary design software.

      2) All calculations.

3) A summary of output results that affect the design. E.g. for concrete beams show size and all reinforcing steel requirements corresponding to that shown on the plans.

2. Structural calculations shall include load ratings for bridges, culverts and any other live-load bearing structures using BRASS, as applicable. All BRASS input data files shall be submitted. For new and rehabilitated bridges, the inventory and operating load ratings including governing live load distribution factors shall be shown on the drawings with the structural notes for future reference.

3. If structural calculation goes through several iterations, the final iteration shall be labeled and set apart from the unused iterations.

4. Provide an electronic text version of final input and output files used in the structural calculations. If SAP 2000 or Midas Civil is used then provide electronic input and output files in lieu of the text version of the files.

5. Provide copies of any reference tables, equations or diagrams used in the structural calculations which are not provided by AASHTO or ASTM.

6. The Consultant shall verify that the structural calculations and requirements correspond to that shown on the plans and specifications. If there are any variances, then the Consultant shall annotate the calculations to provide an explanation.

APPENDIX B

BRIDGE LOAD RATING SUMMARY SHEET

Hawaii Department of Transportation
Bridge Load Rating Summary

Existing Bridge Data

Bridge Number:		Last Load Rating Date:	
Bridge Name:		Last Inspection Date:	
Route:		Inspected By:	
District:		Fracture Critical Member (Y/N):	
Span Type:		Item 58, Deck Rating:	
Bridge Plans Available (Y/N):		Item 59, Superstructure Rating:	
Design Loading:		Item 60, Substructure Rating:	
Past Inventory Rating (HS20):		Bridge Load Posted (Y/N):	
Past Operating Rating (HS20):		Posted Weight Limit:	

Bridge Load Rating Summary

Dead Load Data

Overlay Type:	
Overlay Depth (IN):	
Was Overlay Depth Measured (Y/N):	
Weight of Utilities:	
Weight of other Non-Structural Attachments:	

LRFR Evaluation Factors

Surface Roughness Rating:	
Condition Factor:	
System Factor:	
ADTT (one way):	

Superstructure/Deck Rating Summary

	Vehicle Type	Vehicle GVW (Kips)	Rating Factor	Controlling Member	Controlling Load Effect	IM	Live Load Distribution Factor
Design Load	HL-93 (INV)	N/A					
	HL-93 (OPR)	N/A					
Legal Load	Type 3	50.0					
	Type 3S2	72.0					
	Type 3-3	80.0					
	NRL	80.0					
	SU4	54.0					
	SU5	62.0					
	SU6	69.5					
	SU7	77.5					
Permit Load	HP1	120.0					
	HP2	157.0					
	HP3	209.9					

Substructure Rating Summary

Substructure Rated (Y/N):

Vehicle Type	Vehicle GVW (Kips)	Rating Factor	Controlling Member	Controlling Load Effect	IM	Live Load Distribution Factor
HL-93 (INV)	N/A					
HL-93 (OPR)	N/A					
Legal Load						
Permit Load						

Posting Analysis Summary

Governing Legal Load Rating Factor:	
Governing Legal Load Model:	
Posting Recommended (Y/N):	
Recommended Posting Load:	

Please check the following boxes that apply:

- [ ] Bridge load rating is not governed by deck rating
- [ ] Bridge load rating is not governed by substructure rating
- [ ] Connections do not control the bridge load rating
- [ ] Exterior girder controls the bridge load rating
- [ ] Bridge plans do not exist - Rating based on judgement and current loading

Quality Control/Quality Assurance

Load Rating Engineer
- Name:
- License No.:

- Signature:

Load Rating Checked By:
Quality Assurance By:
Load Rating Date:

Remarks/Recommendations for Bridges without Plans