

**SECTION 1**  
**GENERAL DESIGN REQUIREMENTS**

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## **SECTION 1** **GENERAL DESIGN REQUIREMENTS**

### **1.1 DESIGN SPECIFICATIONS** *(REV. 04/19)*

The design and details of all structures and structure components shall conform to the requirements set forth in the latest editions, including the interim or updated specifications, of the following publications, as modified and amended by the **BDM** and other **CTDOT** manuals and publications:

#### **1.1.1 State of Connecticut, Department of Transportation: (CTDOT)**

- Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, Form (latest)
- Bridge Load Rating Manual
- Highway Design Manual
- Drainage Manual
- Geotechnical Engineering Manual

#### **1.1.2 American Association of State Highway and Transportation Officials (AASHTO)** *(Rev. 12/19)*

- AASHTO LRFD Bridge Design Specifications
- The Manual for Bridge Evaluation
- AASHTO Guide Specifications for LRFD Seismic Bridge Design
- AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete
- AASHTO LRFD Guide Specifications for Design of Concrete-Filled FRP Tubes
- AASHTO LRFD Movable Highway Bridge Design Specifications
- AASHTO LRFD Road Tunnel Design and Construction Guide Specifications
- Bridge Security Guidelines
- Guide Specifications for Bridges Vulnerable to Coastal Storms
- Guide Specifications for Design and Construction of Segmental Bridges,
- Guide Specifications for Design of Bonded FRP Systems for Repair and Strengthening of Concrete Bridge Elements
- Guide Specifications for Design of FRP Pedestrian Bridges
- Guide Specifications for Internal Redundancy of Mechanically-Fastened Built-Up Steel Members
- Guide Specifications for Seismic Isolation Design
- Guide Specifications for the Design of Concrete Bridge Beams Prestressed with Carbon Fiber-Reinforced Polymer (CFRP) Systems
- LRFD Guide Specifications for Accelerated Bridge Construction
- LRFD Guide Specifications for the Design of Pedestrian Bridges,
- LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals
- Technical Manual for Design and Construction of Road Tunnels - Civil Elements

## Connecticut Department of Transportation Bridge Design Manual

- AASHTO LRFD Bridge Construction Specifications
- Guide Design Specifications for Bridge Temporary Works
- Construction Handbook for Bridge Temporary Works
- Guide Specifications for Wind Loads on Bridges During Construction
- A Policy on Design Standards - Interstate System
- A Guide to Standardized Highway Barrier Hardware
- Manual for Assessing Safety Hardware, Second Edition (2016)
- AASHTO Roadside Design Guide
- Standard Specifications for Transportation Materials and Methods of Sampling and Testing

### **1.1.3 American Railroad Engineering and Maintenance-of-Way Association (AREMA):**

- Manual for Railway Engineering

### **1.1.4 American Welding Society (AWS):**

- Bridge Welding Code ANSI/AASHTO/AWS D1.5
- Structural Steel Welding Code ANSI/AWS D1.1
- Structural Welding Code - Aluminum ANSI/AWS D1.2
- Structural Welding Code - Reinforcing Steel ANSI/AWS D1.4
- Guide for the Protection of Steel with Thermal Sprayed Coatings of Aluminum and Zinc and Their Alloys and Composites ANSI/AWS C2.18

### **1.1.5 American Society for Testing and Materials (ASTM):**

- Annual Book of ASTM Standards

### **1.1.6 Federal Highway Administration (FHWA):**

- FHWA Technical Advisory T5140.32, Uncoated Weathering Steel in Structures, dated October 3, 1989
- FHWA-IP-89-016, Design of Riprap Revetments, Hydraulic Engineering Circular No. 11 (HEC-11), March 1989
- FHWA-NHI-01-002, Stream Stability at Highway Structures, Hydraulic Engineering Circular No. 20 (HEC-20), 2001
- FHWA-NHI-01-001, Evaluating Scour at Bridges, Hydraulic Engineering Circular No. 18 (HEC-18), 2001
- FHWA-SA-92-010, Bridge Deck Drainage System, Hydraulic Engineering Circular No. 21 (HEC-21), May 1993
- FHWA-HRT-17-080, Design and Construction Guidelines for Geosynthetic Reinforced Soil Abutments and Integrated Bridge Systems, June 2018

**1.1.7 Prestressed Concrete Institute (PCI):**

- Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products MNL-116

**1.1.8 Society for Protective Coatings (SSPC):**

- Steel Structures Painting Manual, Vol. 1, Good Painting Practice
- Steel Structures Painting Manual, Vol. 2, Systems and Specifications

**1.2 ABBREVIATED REFERENCES** (Rev. 12/19)

The following is a list of abbreviated references used in the **BDM** for the preceding design specifications:

<b>Design Specification</b>	<b>Abbreviated Reference</b>
CTDOT Bridge Design Manual	BDM
CTDOT Form (latest)	Standard Specifications
CTDOT Bridge Load Rating Manual	BLRM
CTDOT Highway Design Manual	HDM
AASHTO LRFD Bridge Design Specifications	LRFD
AASHTO Manual for Bridge Evaluation	MBE
AASHTO Manual for Assessing Safety Hardware	MASH
Manual for Railway Engineering	AREMA
Bridge Welding Code	AWS D1.5
Structural Steel Welding Code	AWS D1.1
Structural Welding Code – Aluminum	AWS D1.2
Structural Welding Code – Reinforcing Steel	AWS D1.4

References throughout the **BDM** use the following syntax:

- To reference a publication, only the abbreviated reference in a bold font is used. For example, **BLRM**.
- To reference a division, section or table in a publication, the abbreviated reference in a bold font followed by a description with a numerical reference in brackets is used. For example, **LRFD** [Table 3.5.1.1].
- To reference an article in a publication, the abbreviated reference in a bold font followed by a numerical reference in brackets is used. For example, **LRFD** [3.6.1.2].

**1.3 LOAD RATINGS** (Rev. 04/19)

**1.3.1 General** (Rev. 12/19)

Load rating requirements are based on the following general scope of work categories:

- New structure/superstructure replacement – includes new and replacement buried structures, superstructure replacements, new structures and full bridge replacements
- Major structure rehabilitation – includes deck replacement, structure widening, structural steel repair and modifications to buried structures
- Minor structure rehabilitation – includes deck patching, resurfacing and safety improvements

Design, legal, permit and emergency vehicle live load ratings shall be performed for all new/replacement bridges and buried structures, and existing bridges and buried structures where rehabilitation/repair of the structure will affect the live load rating in accordance with the **BLRM**, amended as follows:

- All existing bridges and buried structures undergoing minor structure rehabilitation need not be load rated provided a load rating, including the CT-TLC rating, is on file with **CTDOT** that reflects the final condition of the structure after completion of the minor rehabilitation and that meets the requirements of the **BLRM**.

Design, legal, permit and emergency vehicle live load ratings shall be performed for all temporary bridges in accordance with the **BLRM**. The design vehicle live load rating at the inventory level only is not required for temporary bridges that will be in service less than 3 years. The permit vehicle live load rating is not required if the permit vehicles are restricted from using the temporary bridge.

*Commentary: All existing bridges and buried structures undergoing minor structure rehabilitation with resurfacing shall be load-rated to determine if they are adequate for the construction equipment used to remove/place the HMA overlay. If resurfacing increases the overlay thickness on an existing bridge, or additional dead load is added to the bridge, a load rating is required.*

### **1.3.2 Components for Evaluation (BLRM [1.5])**

The bridge components requiring load rating shall be in accordance with the **BLRM**, amended as follows:

- For new bridges and bridges undergoing major structure rehabilitation, the pier caps and columns of all single column and multi-bent piers shall be evaluated.

### **1.3.3 Condition Factor (BLRM [4.1.2]) (Rev. 12/19)**

Condition factors shall be in accordance with the **BLRM**, amended as follows:

For new bridges, the value of the condition factor used in the rating analysis shall be 1.00.

For bridges undergoing a superstructure replacement or major structure rehabilitation, the existing members and component to be rated shall be rehabilitated to a good/satisfactory condition or better, allowing the use of a condition factor with a value of 1.00, unless otherwise indicated in **BLRM**.

For bridges undergoing minor structure rehabilitation and requiring a load rating, the value of the condition rating factor shall reflect the structural condition of the member. The **CTDOT** shall be notified if the value of the condition factor used in the rating is less than 0.95.

#### **1.3.4 System Factor (BLRM [4.1.3])**

System factors shall be in accordance with the **BLRM**, amended as follows:

The use of system factors that correspond to the **LRFD** load factor modifiers for load rating is not allowed.

#### **1.3.5 Average Daily Truck Traffic (BLRM [4.1.4])**

The average daily truck traffic shall be in accordance with **BLRM**, amended as follows:

For new bridges and bridges undergoing a superstructure replacement, load factors for legal and permit load ratings shall be based on average daily truck traffic (ADTT), in one direction, greater than 5000.

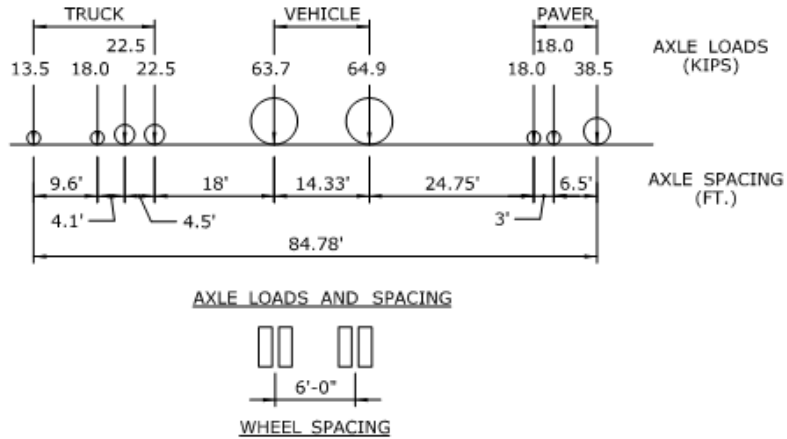
For bridges undergoing other major structure rehabilitation, the average daily truck traffic shall be in accordance with **BLRM** [4.1.1].

#### **1.3.6 Permit Load Rating (BLRM [4.4])**

Permit vehicle load ratings shall be performed for permit vehicles in accordance with the **BLRM**, amended as follows:

A load rating shall be performed, on all projects for which a load rating evaluation is required, for the following vehicle, load factor criteria and analysis parameters:

Permit load vehicle: CT-TLC (Paving Train)  
Permit Type: Special or Limited Crossing  
Frequency: Single Trip  
Loading Condition: Mix with traffic  
Distribution Factor: One lane  
Dynamic Load Allowance: 0.00



Note: TLC = tri-load combination of vehicles in paving train

**CT-TLC PERMIT LIVE LOAD VEHICLE**

279.6 kip on 9 axles

**1.3.7 Minimum Acceptable Rating Factors (Rev. 12/19)**

The minimum acceptable design, legal, permit and emergency vehicle rating factors for permanent bridges, are based on the general scope of work categories, and shall be no less than the values shown in Table 1.3.7-1.:

**Table 1.3.7-1**

<b>Rating Procedure</b>	<b>Minimum Acceptable Rating Factor (RF)</b>		
	<b>New Structure/ Superstructure Replacement</b>	<b>Major Structure Rehabilitation</b>	<b>Minor Structure Rehabilitation</b>
Design Load Rating, Evaluation Level – Inventory	1.20	1.20, unless permitted in writing by the CTDOT.	Report value
Design Load Rating, Evaluation Level – Operating	Report value	Report value	1.00, unless permitted in writing by the CTDOT.
Legal Load Rating	1.20	1.20, unless permitted in writing by the CTDOT.	1.00, unless permitted in writing by the CTDOT.
Permit Load Rating	1.20	1.20, unless permitted in writing by the CTDOT.	Report value, may be less than 1.00



Rating Procedure	Minimum Acceptable Rating Factor (RF)		
	New Structure/ Superstructure Replacement	Major Structure Rehabilitation	Minor Structure Rehabilitation
Permit Load Rating, CT-TLC	1.10	1.10, unless permitted in writing by the CTDOT.	Report value, may be less than 1.00
Emergency Vehicle Rating	1.20	1.20, unless permitted in writing by the CTDOT.	1.00, unless permitted in writing by the CTDOT.

The above table applies to all limit states. Fatigue and Service limit states shall be included under the “Design Load Rating Evaluation Level - Inventory” requirements in Table 1.3.7-1.

The minimum acceptable design, legal, permit and emergency vehicle rating factors for temporary bridges shall be 1.00.

When required, written permission shall be obtained from the Principal Engineer.

*Commentary: The target minimum acceptable rating factor of 1.20 was selected to account for future deterioration of members and components that would require the use of a condition factor of 0.85 and result in a rating factor greater than 1.00.*

## **1.4 TRANSPORTATION OF STRUCTURAL MEMBERS AND COMPONENTS** (REV. 04/19)

### **1.4.1 Background**

In general, the length, width, height and weight of a prefabricated structural member or component for use in a highway, pedestrian or railway structure is limited by the ability to ship the item over State highways and bridges.

These physical properties are indirectly limited by the vehicle regulations in the *Connecticut General Statutes*. The *General Statutes* include the following limitations on the dimensions of vehicles using State highways without the need for a permit:

- Vehicle Width (Section 14-262(a)(1)) - The width of a vehicle and combination vehicle and trailer, including its load, is limited to 8’-6”, without a permit.
- Vehicle Length (Section 14-262(c)) - The length of the semi-trailer portion of a tractor-trailer unit, including its load, is limited to 48 feet, without a permit.
- Vehicle Height (Section 14-264) - The height of a vehicle, with its load, is limited to 13’-6”, without a permit.

- Vehicle Weight (Section 14-267a(b)(8)) - The gross vehicle weight (weight of vehicle including its load) is limited to 80,000 pounds, on vehicles with a 51 feet wheelbase, without a permit.
- Axle Weights of Vehicles (Section 14-267a) - The axle weights of vehicles vary and are determined by vehicle type and axle spacing.

Section 14-270 of the *General Statutes* assigns authority to the Commissioner of Transportation to grant permits for vehicles exceeding the limits of the vehicular regulations.

To facilitate construction of the **CTDOT** projects, Policy Statement HO-10 was developed. It states that the **CTDOT** will grant a permit via an authorized permit route for the transportation of “any structural beam (member or component) that measures 120 feet or less and weighs no greater than 120,000 pounds provided the individual axle weights on the vehicle and trailer transporting the beam (member or component) do not exceed 20,000 pounds.” The phrase “structural beam” may be interpreted to mean any structural member or component.

### **1.4.2 Design Requirements**

The vehicle regulations of the *General Statutes* and **CTDOT** Policy Statement HO-10 establish design guidelines for the length, width, height and weight of prefabricated structural members and components.

To avoid problems associated with transporting materials during construction, prefabricated structural members or components that will require a permit to be transported should be identified early in the design phase.

The maximum member or component shipping length, width, height and weight shall be shown on the contract plans. For the preliminary submissions, the best available information should be shown on the plans. The actual, as designed, shipping lengths, widths, heights and weights should be shown on the plans for the final submission for review.

The shipping information will be reviewed by the **CTDOT** Oversize and Overweight Permits Section, which will determine if the members are transportable.

If a member exceeds the length and weight limits of **CTDOT** Policy Statement HO-10, the designer must submit adequate justification with a preliminary submission to **CTDOT**. If sufficient justification exists, the **CTDOT** Office of Engineering will request a waiver of HO-10 and confirmation that a permit will be granted to transport the member in accordance with Section 14-270 of the *General Statutes* from the **CTDOT** Oversize and Overweight Permits Section.

If a member, when transported, will exceed the height and width limits of the *General Statutes*, the designer must submit adequate justification with a preliminary submission to **CTDOT**. If sufficient justification exists, the **CTDOT** Office of Engineering will request confirmation that a permit will be granted to transport the member in accordance with Section 14-270 of the *General Statutes* from the **CTDOT** Oversize and Overweight Permits Section.

The special provision entitled “Section 1.06 - Control of Materials” should be included in all projects. This special provision addresses the shipping of materials in accordance with the *Connecticut General Statutes* and the **CTDOT** Policy Statement HO-10.

If a member exceeds the height and width limits of the *General Statutes* or the length and weight limits of HO-10, and the **CTDOT** Oversize and Overweight Permits Section confirms that a permit will be granted in accordance with Section 14-270 of the *General Statutes* to transport the member, the project’s contract documents should indicate that the **CTDOT** has confirmed with the Oversize/Overweight permit office that the proposed members are eligible to be “Permitted” in accordance with the **CTDOT** Permitting Regulations.

## **1.5 BRIDGE INSPECTION AND EVALUATION REQUIREMENTS (REV. 04/19)**

### **1.5.1 Inspection Access**

Per a recommendation in Administration Memorandum No. 80, all bridges shall include features, both off and on the structure, that will make them accessible to bridge inspectors and facilitate the future inspection of the structure. These features may include a shelf at the face of the abutment stem, ladder stops on slopes, catwalks, ladders, access doors (in bottom flanges and the ends of box girders), hand rails and cables, lighting and electrical outlets, and any other facility necessary for the inspection of the structure. The features may also include the design and placement of structural members and components (such as generous bridge seats for box girder structures, internal cross frames and bracing in box girders) that allow access for bridge inspectors.

For bridges that are excessively wide, where normal inspection equipment cannot access the interior members, the bridge may require permanent movable inspection platforms or permanent catwalks. The need for and type of permanent inspection platforms shall be determined by the **CTDOT**.

### **1.5.2 Notice to Bridge Inspectors**

As a result of a recommendation in Administration Memorandum No. 80, the Designer shall note on the General Plan any members and components needing special attention, such as fracture critical members, during the inspection of the structure. This information shall be contained in the “Notice to Bridge Inspectors” block.

The “Notice to Bridge Inspectors” block shall be shown on the Structure Layout for Design (SL/D) Plans and fully completed on the Final Plans for Review.

### **1.5.3 Inspection Manuals**

For movable bridges, segmental bridges and other bridges as directed by **CTDOT**, the Designer shall provide an inspection manual. The manual should contain the instructions, procedures, check lists, diagrams and details necessary to perform a complete in-depth

inspection of the various members and components of the bridge. Inspection manuals shall be submitted with the final submission for review.

## **1.6 DESIGN FEATURES (REV. 04/19)**

### **1.6.1 General Features of Design**

#### **1.6.1.1 Width**

Generally, the curb to curb width of highway bridges shall match the approach roadway (including shoulders). For highway bridges with off or on ramps, the curb to curb width shall match the geometry required for the roadway. Greater bridge widths may be necessary to meet sight distance requirements, to facilitate the maintenance of traffic and stage construction requirements or to accommodate standard width structural members.

Per Section 13a-86 of the *Connecticut General Statutes*, any bridge constructed or reconstructed on a State maintained highway with two or more lanes shall have a clear width of roadway of not less than 28.00 feet, exclusive of the width of any sidewalk, unless in the judgment of the Commissioner a lesser width is warranted.

#### **1.6.1.2 Sidewalks**

Sidewalks shall be provided on bridges in accordance with **CTDOT** Policy Statement E&C-19. The minimum sidewalk width shall be 5.0 feet. Sidewalk widths may be increased in areas of heavy pedestrian traffic, on designated bike routes, or at locations requiring additional sight distance.

Sidewalks should be carried across a bridge if the approach roadway has sidewalks or sidewalk areas. Elsewhere, one or two sidewalks may be provided as warranted by current developments, anticipated area growth, traffic or pedestrian studies, etc.

Sidewalk curb heights on structures shall match the exposed height of the approach curbing. Where curbs are not provided on the approaches, the exposed curb height on the structure shall be 6 inches.

Generally, the curb-to-curb width of pedestrian bridges shall match the approach pathway width.

#### **1.6.1.3 Cross Section**

Generally, deck cross slopes in both the travel lanes and the shoulders of highway bridges shall conform to the roadway cross slopes found in the **HDM**. Mechanical screeds, used when placing cast-in-place concrete decks, can accommodate multiple cross slope breaks. On bridges with precast components, such as precast adjacent box beams, the bituminous concrete overlay may be placed to match the approach roadway cross section.

#### **1.6.1.4 Profile**

The profile for highway bridges shall match the approach roadway. Preferably, the profile grade of all bridges shall provide for longitudinal surface drainage.

##### **1.6.1.4.1 Clearances**

###### **1.6.1.4.1.1 Structures Adjacent to or Crossing over Roadways (Rev. 11/04)**

The minimum horizontal and vertical clearance for any structure adjacent to or crossing over a roadway shall conform to the **HDM**. The provisions of **FHWA**'s "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges" should be considered when the clearances specified in the **HDM** cannot be achieved, and a Design Exception is required to allow a lesser clearance.

The lowest portion of a structure mounted sign support shall be a minimum of 12 inches above the lowest component of the fascia member of the bridge to which it is attached.

###### **1.6.1.4.1.2 Structures Crossing over Waterways**

Navigational clearances, both horizontal and vertical, shall conform to the requirements of the U.S. Coast Guard. Permits for construction of a bridge over navigable waterways shall be obtained from the U.S. Coast Guard and/or other agencies having jurisdiction.

The waterway opening shall be consistent with the hydraulic characteristics of the waterway. For additional information, see **BDM** [1.4].

###### **1.6.1.4.1.3 Structures Adjacent to or Crossing over Railroads**

The minimum horizontal clearance for any structure adjacent to or crossing over a railroad shall conform to the **AREMA**. The horizontal clearance for any structure adjacent to or crossing over a railroad shall be in accordance with standards established and used by the affected railroad in its normal practice. The determination of the horizontal clearance shall also consider the economics and constructability of the structure, influence of railroad loads on the structure, site conditions, drainage and utility requirements, railroad access and future track expansion.

The minimum vertical clearance for any structure crossing over railroad tracks is limited by Section 13b-251 of the *Connecticut General Statutes*. The minimum vertical clearance for any structure crossing over railroad tracks shall be 20.50 feet (measured from the top of the rail to the bottom of the structure). The minimum

vertical clearance for any structure crossing over railroad tracks on which trains are operated by means of overhead electrical wires (electrified tracks) shall be 22.50 feet (measured from the top of the rail to the bottom of the structure). If the construction work includes only deck replacement (the removal and replacement of the bridge deck and supporting members) or minor widening of the structure, and the existing piers or abutments remain in place, the minimum vertical clearance shall be the structure's existing overhead clearance or 18.50 feet, whichever is greater.

#### **1.6.1.4.1.4 Through-Truss Highway Bridges**

The minimum vertical clearance from the roadway to the overhead cross bracing of a through-truss highway bridge should not be less than 17.50 feet.

#### **1.6.1.4.1.5 Railway Bridges**

Railway bridge clearances, both horizontal and vertical, shall conform to the **AREMA**.