SECTION 3
LOADS AND LOAD FACTORS

TABLE OF CONTENTS

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3.1 LOAD MODIFIER (LRFD [1.3.2])

3.1.1 Ductility (LRFD [1.3.3])

The ductility load modifier shall be no less than 1.0 for the strength limit state.

3.1.2 Redundancy (LRFD [1.3.4])

The design of non-redundant members or components is not permitted, unless approved in writing by the **CTDOT**.

Single-cell box superstructures and single column piers shall be considered non-redundant.

The redundancy load modifier shall be no less than 1.0 for the strength limit state.

3.1.3 Operational Importance (LRFD [1.3.5])

The operational importance load modifier shall be no less than 1.0 for the strength limit state.

*Commentary: The redundancy of members and components is addressed by the system factor described in the **MBE** and included in the load rating of the bridge. The determination of the operational importance load modifier requires the Operational Classification the bridge, see **BDM*** [3.8.2].

3.2 LOAD FACTORS AND LOAD COMBINATIONS (LRFD [3.4])

3.2.1 Load Factors and Load Combinations (LRFD [3.4.1])

For permanent bridges, the load factor for design vehicle live load for the Extreme Event I limit state shall be 0.50.

For temporary works, such as jacking devices, falsework and shoring, the load factor for design vehicle live load for the Strength I limit state shall be 1.35.

For temporary bridges that will be in service less than 3 years, the load factor for design vehicle live load for the Strength I limit state shall be 1.35. For temporary bridges that will be in service less than 3 years, the load factor for design vehicle live load for the Extreme Event I limit state shall be 0.0.

Commentary: Temporary bridges shall be designed at the "operating level" for the design vehicle live load.

3.2.2 Load Factors for Construction Loads (LRFD [3.4.2.1])

When investigating load combinations for the Strength III limit state for load effects during construction, the load factor for wind shall not be less than 1.0.

3.3 PERMANENT LOADS (LRFD [3.5])

3.3.1 Dead Loads

The unit weights used in computing dead loads shall be in accordance with **AASHTO LRFD** [Table 3.5.1-1], amended as follows:

Table 3.3.1

Material	Unit	Load
Compacted sand, gravel, silt and clay[1]	kcf	0.125
Reinforced concrete or prestressed concrete	kcf	**AASHTO LRFD** [Table 3.5.1-1] value plus 0.005
Bituminous concrete overlay, HMA overlay[2]	kcf	0.155

Commentary: (1) Includes typical items Pervious Structure Backfill, Granular Fill, and Subbase, and in-situ soils. (2) Bituminous concrete (HMA) overlay unit weight accounts for increased weight of aggregate typically used in CT.

3.3.2 Overlay Allowance

All vehicular bridges shall be designed to account for the load effects due to a bituminous concrete/HMA overlay, including bridges detailed to be constructed without an initial overlay.

*Commentary: For minimum overlay thickness, see **BDM*** [8.2.1.2].

3.4 CONSTRUCTION LOADS

3.4.1 Construction Loads and Load Effects

All bridges shall be designed to account for construction loads and their effects to ensure the adequacy of the structure during all phases of construction. Construction loads, including dynamic effects, assumed in the design shall be shown on the contract documents.

Construction live load shall be no less than 0.050 ksf.

3.5 LIVE LOADS (LRFD [3.6])

3.5.1 Live Load *(Rev. 12/19)*

The design vehicle live load, during all phases of construction, shall be in accordance with **LRFD** [3.6.1.2.1] for both new and existing permanent bridges as well as temporary bridges. In addition to the design vehicle live load specified in the **LRFD,** the load rating requirements of **BDM** [1.2] shall be satisfied.

Live load effects shall be considered in the design of temporary works, such as jacking devices, falsework and shoring, required for construction.

*Commentary: The **LRFD** and the **LRFR** are design specifications and rating specifications, respectively. Since not all bridge components are subject to load rating, vehicular bridges should be designed by the **LRFD** and rated in accordance with **BDM*** [1.2].

3.6 EARTH PRESSURES (LRFD [3.11])

3.6.1 Lateral Earth Pressure

For Pervious Structure Backfill, the effective angle of internal friction shall be taken as equal to 35 degrees.

3.6.2 Live Load Surcharge (LRFD [3.11.6.4])

Permanent earth retaining structures shall be designed for a minimum surcharge loading equivalent to 2 feet of soil. The load factor shall be in accordance with **LRFD** [3.4.1].

3.6.3 Unbalanced Loads

Structures with skewed end sections, such as concrete tunnels, integral or semi-integral abutments, rigid frames, box culverts, etc., will require special consideration in the design and sequence of backfilling in order to prevent cracking due to unbalanced loading. Backfilling requirements shall be shown on the plans to mitigate the load effects due to unbalanced backfilling.

Commentary: For permanent structures designed and built during construction, backfill requirements should be included in the contract documents.

3.7 FORCE EFFECT DUE TO SUPERIMPOSED DEFORMATIONS (LRFD [3.12])

3.7.1 Temperature Range for Procedure A

The temperature ranges for cold climates shall be used for Procedure A in accordance with **LRFD** [3.12.2.1].

3.8 EARTHQUAKE EFFECTS (LRFD [3.10])

3.8.1 General

All conventional bridges, new and existing bridges being rehabilitated, shall be designed for earthquake load effects in accordance with **LRFD** [3.10], except as noted below. Conventional bridges have slab, beam, girder, box-girder, deck unit, and truss superstructures; have single or multiple column piers, wall type piers or pile bents; and are founded on shallow or piled footings or shafts.

- All existing conventional bridges in Seismic Performance Zone 1 and undergoing major rehabilitation, such as bridge widening, superstructure replacement, deck replacement, bearing replacement, shall be analyzed and designed for earthquake load effects, unless specifically waived by **CTDOT**.

- All existing conventional bridges in other than Seismic Performance Zone 1 and undergoing major rehabilitation shall be analyzed for earthquake load effects. Bridge specific direction on how to address the results of the analysis will be provided by **CTDOT**.

- All existing bridges undergoing minor rehabilitation, such as deck patching, resurfacing and safety improvements need not be analyzed or designed for earthquake load effects.

All non-conventional bridges, new and existing bridges being rehabilitated, shall be designed for earthquake load effects as directed by the **CTDOT.** Non-conventional bridges include bridges with cable-stayed, cable-suspended superstructures, bridges with truss towers or hollow piers for substructures and arch bridges.

All buried structures described and listed in **LRFD** [C12.5.1], including associated end walls, wing walls and head walls, need not be analyzed or designed for earthquake load effects, except where they cross active faults.

The need to design retaining walls for the Extreme Event 1 limit state shall be determined in accordance with **LRFD** [11.5.4.2].

3.8.2 Operational Classification (LRFD [3.10.5])

Critical and Essential Bridges are defined as those bridges that are:

1. On or over the following National Highway System (NHS) routes:

    a. Eisenhower Interstate System
    b. Other NHS Routes
    c. Strategic Highway Network (STRAHNET) Routes and Connectors

2. On designated emergency evacuations routes.

CTDOT does not make any performance distinction between Critical and Essential bridges.

Commentary: CTDOT bridge inspection reports include the following fields:

NBI 100 - indicates if the inventory route on the bridge is "on" or "not on" a STRAHNET route.
NBI 104 - indicates if the inventory route on the bridge is "on" or "not on" the NHS.

Information on the STRAHNET system can be found on the following website:

https://www.fhwa.dot.gov/policy/2004cpr/chap18.cfm

A map of the National Highway System in Connecticut may be found on the following website:

https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/connecticut/ct_connecticut.pdf

Additional information on the NHS can be found on the following website:

http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/