# Section 3 - AASHTO LRFD Bridge Design Specifications with NJDOT Stipulations

## 3.1 Load and Resistance Factor Design (LRFD) Philosophy

The design of new structures and new elements of rehabilitated bridge structures in New Jersey shall be completed with the use of the *AASHTO LRFD Bridge Design Specifications*. Guidance for the Reconstruction or Rehabilitation of existing bridge structures is provided in Section 8 of this Manual.

The LRFD bridge design philosophy is based on the premise that four Limit States are stipulated to achieve the basic design objectives of constructability, safety and serviceability. All Limit States are given equal importance.

The four Limit States are:

**Service Limit State**: Stress, deformation and crack width are limited under service conditions.

**Fatigue and Fracture Limit State**: Fatigue stress range is limited for the expected number of stress cycles due to a single design truck in order to control crack initiation and propagation, and to prevent fracture during the design life of the bridge.

**Strength Limit State**: Strength and stability are provided to resist the significant load combinations that a bridge is expected to experience in its design life.

**Extreme Event Limit States**: Structures are proportioned to resist collapse due to extreme events, such as, major earthquake, flood, ice flow, collision by a vessel, etc.

Equation 1.3.2.1-1 of the *AASHTO LRFD Bridge Design Specifications*, unless otherwise specified, must be satisfied for each Limit State:

Where $\eta = \eta_D \eta_R \eta_I \geq 0.95$

$\eta$ = A factor relating to ductility, redundancy and operational importance.
$\eta_D$ = A factor relating to ductility
$\eta_R$ = A factor relating to redundancy
$\eta_I$ = A factor relating to importance
$\gamma_I$ = Load factor: A statistically based multiplier
$\phi$ = Resistance Factor: A statistically based multiplier
$Q_I$ = Force Effect
$R_n$ = Nominal Resistance
$R_r$ = Factored Resistance: $\phi R_n$

Subsection 1.3 of the LRFD Specifications may be referred to for additional commentary concerning the philosophy of the Specifications' development.

## 3.2 Vehicular Bridge Structures

The current Edition of the *AASHTO LRFD Bridge Design Specifications* (with current Interims), with the following stipulations to the respective AASHTO LRFD Sections, shall govern the design of bridge structures in New Jersey.

**Note**: The following Section numbers refer to the Section numbering of the *AASHTO LRFD Bridge Design Specifications*.

**Section 1 - Introduction**

1.3.5 Operational Importance

The following is added:

The Operational Importance strength limit state classification shall be as follows:

NHS Structures - $n_I = 1.05$

NON-NHS Structures - $n_I = 1.00$

**Section 2 - General Design and Location Features**

2.3.2 Bridge Site Arrangement

2.3.2.2 Traffic Safety

2.2.2.1 Protection of Structures

The following is added:

The *NJDOT Design Manual Roadway* shall be referred to for additional guidance concerning lateral clearance requirements.

2.3.3 Clearances

2.3.3.1 Navigational

The following is added:

The guidance provided in Section 42 of this Manual shall be followed in procuring U.S. Coast Guard permits.

2.3.3.2 Highway Vertical

The following is added:

The minimum vertical clearances that are tabulated in the following Table are based on the provisions of the *AASHTO A Policy on Geometric Design of Highways and Streets.* For Interstate Highways, *AASHTO A Policy on Design Standards Interstate System* will apply. The specified clearances shall control the design of bridge structures in New Jersey.

**Table 2.3.3.2 - Minimum Vertical Clearances for Bridges & Structures**

| Roadway Functional Classification Facility Type | Vehicular and Railroad Over Crossings | Pedestrian and Bikeway Over Crossings | Overhead Sign Structures | Tunnels | Notes |
|---|---|---|---|---|---|
| Interstates<br>Freeways<br>Expressways | 16’–0” | 17’–0” | 17’–3” | 16’–0” | 1,2,3,8 |
| Rural Arterials<br>Urban Arterials | 16’-0” | 17’-0” | 17’-3” | 16’-0” | 1,2,3,8 |
| Local Roads and Streets and Collector Roads and Streets | 14’-6” | 17’-0” | 17’-3” | 14’-6” | 1,2,8 |
| Railroads<br><br>Electrified Tracks | 23’-0”<br><br>24’-6” | 23’-0”<br><br>24’-6” | --<br><br>-- | 23’-0”<br><br>24’-6” | 4<br><br>4 |
| Inter-Coastal Waterway<br><br>Navigable Waterways<br><br>Other Waterways | 55’-0”<br><br>Varies<br><br>Varies | --<br><br>--<br><br>-- | --<br><br>--<br><br>-- | --<br><br>--<br><br>-- | 5<br><br>6<br><br>7 |
| Existing Bridges and Structures | -- | -- | -- | -- | 8 |

**Notes for Table 2.3.3.2**

1. Design Exceptions are required for proposed clearances that are less than the minimum values shown in this table. The clearance shall apply over the entire roadway width including any contiguous auxiliary lanes and shoulders. Approval of a Design Exception should follow the process in the current NJDOT Design Exception Manual.
2. When an existing vertical clearance is proposed to be reduced, but will still meet or exceed the minimum, written approval for a waiver is required from the State Transportation Engineer. For new structures, total replacements, or full superstructure replacements, an additional 6 inches of vertical clearance is required for future resurfacings or a waiver is required from the State Transportation Engineer.
3. In highly urbanized areas where a 16’-0” vertical clearance is required, a minimum clearance of 14’-6” may be provided if there is a route within the approximate location of the bridge in question that provides an existing 16’-0” minimum vertical clearance. In such instances, signing to the alternate route should be called for in the Contract Plans. A Design Exception is still required.
4. The 23’-0” clearance above the top of rails (24’-6” for electrified tracks) includes an allowance of 1’-0” for future ballasting of the railroad tracks and minor structure encroachment during construction or maintenance operations. Exceptions to the clearances may be approved when ordered by the State

regulatory agency having jurisdiction over such matters. A greater vertical clearance may be required at individual locations where necessary and when justified on the basis of extraordinary site conditions.

5. Exceptions to the standard 55’-0” clearance (above M.H.W.) may be approved if justified by marine traffic and cost studies or ordered by the U.S. Coast Guard.
6. Clearance contingent on marine traffic and cost studies. Clearance subject to approval by the U.S. Coast Guard.
7. Freeboard clearance contingent on hydraulic and hydrologic studies. Subject to approval by N.J. Division of Water Resources.
8. State Laws, N.J.S.A. 27:5G-1 through 27:5G-4, require that every bridge or overpass carrying municipal, county, or state roads, including railroads, with a vertical clearance of less than 14’-6” from the roadway beneath shall have a minimum clearance marked or posted thereon in accordance with the current standards prescribed by the "Manual of Uniform Traffic Control Devices for Streets and Highways". All bridges over State owned roadways with a minimum vertical clearance of less than 14’-9” shall also be posted.

   Signs, warning persons operating motor vehicles that they are approaching a bridge or overpass with less than 14’-6” clearance, shall be placed at the last safe exit or detour preceding the bridge or overpass. The minimum clearance of the bridge or overpass shall be indicated on these signs.

   The signs required by this section shall be maintained by the appropriate government entity which has jurisdiction over the roadway underneath the bridge or overpass. The above provisions do not apply to toll road authorities.

**General Vertical Clearance Provisions**

If it is anticipated that future lanes will be required for the lower roadway, the clearance stipulated in this policy shall be applied to the future lane.

The clearance for ramps shall be that of the connecting highway. In the case where a ramp connects highways with different vertical clearance criteria, the higher clearance shall be used.

For spans between 120’–0” and 150’-0”, the need for a bolted splice (located near one quarter-point) should be anticipated in calculating the minimum vertical clearance. An allowance of ¾ inch (fastener head) plus thickness of bottom flange splice plate shall be considered.

For spans over 150 feet, two splices located near each quarter-point should be anticipated. An allowance of ¾ inch (fastener head) plus thickness of bottom flange splice plate shall be considered.

2.3 Location Features

Highway Horizontal

The following is added:

Lateral clearances shall conform to Section 5-11 of the *NJDOT Design Manual – Roadway*.

Railroad Overpass

The following is added:

Refer to Table 2.3.3.2 of this Manual for Minimum Vertical Clearance requirements.

## 2.5 Design Objectives

### 2.5.2.2 Inspectability

The following is added:

For all bridge structures, to assure inspectability access, the design details shall be reviewed and certified by an Engineer who meets NJDOT NBIS requirements for qualification as a team leader.

### 2.5.2.3 Maintainability

The second sentence of the 1st paragraph is changed to:

When the climatic and/or traffic environment is such that the bridge deck may need to be replaced prior to the required service life, provisions shall be shown on the plans for replacement of the deck and/or bearings.

### 2.5.2.4 Rideability

The last paragraph is deleted and the following is added:

A thickness of ½ inch shall be provided to compensate for surface wear. The ½ inch of the concrete deck slab thickness shall be considered as a wearing surface. Consequently, it shall be considered as dead load, but shall not be considered effective in carrying secondary dead loads (except future overlay wearing surface) or live loads and impact.

### 2.5.2.6 Deformations

#### 2.5.2.6.2 Criteria for Deflection

The following is added:

The criterion stated within this Subsection is required for design of New Jersey bridge structures. The structural analysis shall be based on service limit state load combinations and the criteria in Article 2.5.2.6.2. of the AASHTO LRFD Specifications. The following specified deflection limits shall be used for steel, aluminum and/or concrete bridge construction:

- Vehicular load, general — Span/1000
- Vehicular and pedestrian loads — Span/1000
- Vehicular load on cantilever arms — Span/400
- Vehicular load and pedestrian loads on cantilever arms — Span/400