SECTION 2 - LOADS & RATINGS

2.1 - DESIGN LOADS ON STRUCTURES

At the time of this printing, the Thruway Authority has designed structures predominantly using **AASHTO Allowable Stress Design (ASD) or AASHTO Load Factor Design (LFD)**. A recent federal mandate requires all new structures using federal funding to be designed using the**AASHTO Load and Resistance Factor Design (LRFD)**method in the current **AASHTO LRFD 4th Edition** of their manual. The NYSDOT has adopted this design method for all of their structures. **LRFD** at the Authority will be phased in on all projects in the following manner:

Superstructure Design: On bridge replacement projects, superstructures shall be designed using **LRFD** procedures. The results shall be verified as described in Subsection 2.1.1.

Substructure Design: Substructures shall be designed using **LRFD** procedures. New flexural substructure components must meet the minimum "d" requirement for a balanced design and a minimum reinforcement requirement of 4/3 of that required by the design loading.

Foundation Design: Foundations shall be designed using **LRFD** requirements for spread footing and pile supported substructures. The designer shall provide the factored loads to the Geotechnical Engineer for these foundation designs. Foundation designs shall be verified using **ASD**. The designer shall provide the unfactored loads from the **LRFD** calculations to the Geotechnical Engineer for these **ASD** foundation design verifications.

2.1.1 - DESIGN LIVE LOADS

The minimum design live loading for **LRFD** is designated HL-93. It is a modification of the HS20-

44 live loading in the **AASTO 17th Edition ASD/LFD**. HL-93 consists of an HS20 truck **and** an HS20 lane load on the structure compared to the **LFD** use of an HS20 truck **or** lane load with additional point loads. The purpose of the modification is to more accurately portray the loading effects of HS20 traffic on a bridge structure. However, the Authority has been using a modified version of HS20-44 called HS-25 for several years as have many other transportation agencies throughout the country. This modification increased the HS20 loads by 25%. This modification accounts for trucks that have been getting larger and heavier since HS20 was introduced in 1944. It also ensures greater durability of the structures by making them more robust. Because of this additional loading requirement, it is not possible to simply design for HL-93. In order to maintain our recognition of heavier loads on our roads and an acceptable margin of added durability, designers need to apply additional live loading requirements when designing bridge components.

Alternate 1 Live Load Design Procedure:

The current **NYSDOT** procedure isto design for HL-93 and then check the design using their permit vehicle. See Figure 2.1.1. This is an acceptable approach which satisfies the requirements of **LRFD**, recognizes heavier loads on our roads, and provides a margin of added durability. If the design is not adequate for the permit vehicle under Service II loading, the designer must modify the members in order to satisfy this requirement. When completed, the designer shall run an **LFD** HS-25 analysis of the design. If the design is not reasonably close to HS-25 (HS-22, a load factor of 0.88 or higher [**NYSTA** criteria]), the designer must modify the members to satisfy this requirement. If the structure does satisfy this requirement, then the designer must check the HL-93 live load deflection.

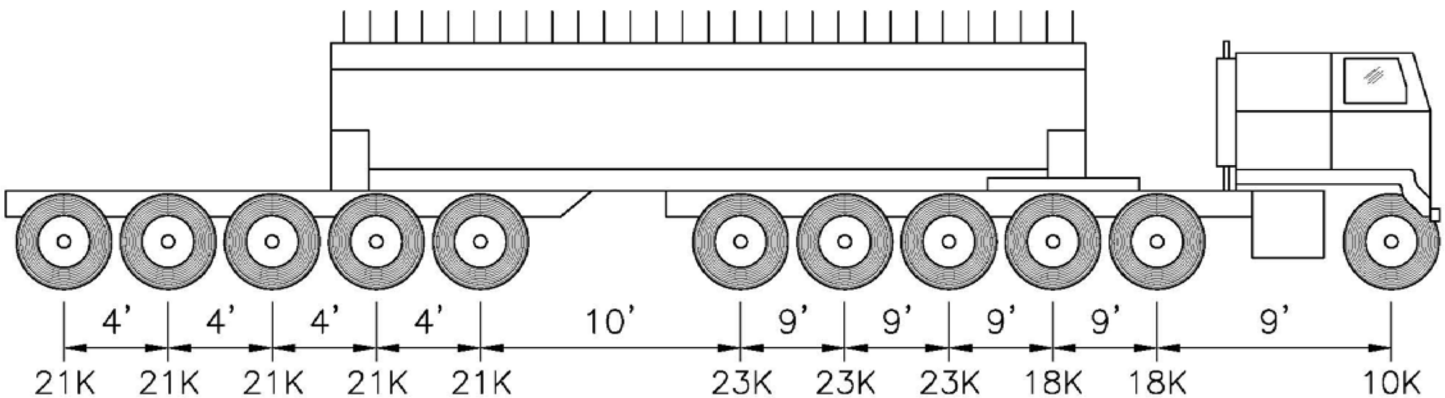

FIGURE 2.1.1
NYSDOT
DESIGN PERMIT VEHICLE
N. T. S.

If the deflection is not less than or equal to L/1000 (NYSTA criteria), the designer must modify the members to satisfy this requirement. If the structure does satisfy this requirement, the girder design can be considered complete. Since the **LRFD** design includes more accurate loads and distribution factors, it is not necessary to meet the **LFD** HS-25 rating to account for heavier loads on our roads and achieve an acceptable margin of added durability. On rehabilitation projects the designer shall attempt to meet the same criteria. If this is not possible, the structure must have the capacity to meet the HL-93 and HS-20 live loading criteria with a maximum live load deflection of L/800 under these loadings.

<u>Alternate 2 Live Load Design Procedure:</u>

Another acceptable approach is to apply a modification factor to the HL-93 load. Just as HL-93 is intended as a more accurate portrayal of the loading effects of HS20 traffic on a bridge structure, **AASHTO LRFD 4th Edition** suggests the use of a modification factor to the HL-93 load to provide a more accurate portrayal of the loading effects of heavier **LFD** design loads such as HS-25. A direct correlation to what was done in **LFD** would suggest using a modification factor of 1.25. As expected, this increases the HL-93 loading by 25%. However, a modification factor this high may not be necessary on all structures. As stated above, since **LRFD** uses more accurate loads and distribution factors, the increase in loading to recognize heavier loads on our roads and achieve an acceptable margin of added durability does not require as much of an increase in the HL loading as is required for the HS loading. In this approach, the designer should investigate various multiplication factors to find the most appropriate for each project to satisfy the permit vehicle and minimum HS & live load deflection requirements described above and in Table 2.1.1 on the next page. On rehabilitation projects the designer shall attempt to meet the same criteria. If this is not possible, the structure must have the capacity to meet the HL-93 and HS-20 live loading criteria with a maximum live load deflection of L/800 under these loadings.

MINIMUM LIVE LOADING REQUIREMENTS				
	HL-93	PEMIT VEHICLE	HS-25	LIVE LOAD DEFLECTION
NEW STRUCTURES	1.0 LOAD FACTOR	SERVICE II 1.0 LOAD FACTOR	0.88 LOAD FACTOR	L/1000
EXISTING STRUCTURES	1.0 LOAD FACTOR	----	0.80 LOAD FACTOR	L/800

TABLE 2.1.1

2.1.2 - DESIGN DEAD LOADS

Design dead loads shall be determined from the details presented in this manual. They shall be applied using acceptable engineering principles and practices. Dead loads shall include the weight of all superstructure components placed prior to or in conjunction with the deck concrete. All new structures, bridge replacements, and superstructure replacements shall be designed using the appropriate new deck section as described in Section 3 – Deck Systems. Two inch minimum concrete haunches shall be included over the main stringers in the calculation of dead loads for these structures. For the rehabilitation of existing structures, the dead loads shall be calculated based on the existing bridge cross section. The designer should have the existing deck cored in several places to determine the thickness of the actual deck and overlay. The designer should also verify whether or not the existing superstructure contains concrete haunches during the site visit.

2.1.3 - DESIGN AND FUTURE SUPERIMPOSED DEAD LOADS

Design and future superimposed dead loads shall be determined from the details presented in this manual. They shall be applied using acceptable engineering principles and practices. For all new structures, bridge replacements, and superstructure replacements, the future superimposed dead loads will include a future additional wearing course as described in Section 3. For the rehabilitation of existing structures, the inclusion of this future additional wearing course shall only be included in the design if the load does not reduce the live load capacity below HL-93. If the future additional wearing course is not included, this fact must be stated clearly, directly under the Controlling Load Rating Table on the Contract Plans Title Sheet.

2.1.4 - DESIGN LOAD TABLE

A Design Load Table similar to that shown below shall appear on the plans for each structure. If the design loads vary from girder to girder, a table is required for each design load case.

	DESIGN LOAD TABLE/GIRDER		
	UNIT	FASCIA GIRDER LOAD/FT	INTERIOR GIRDER LOAD/FT
DEAD LOAD	Slab	_______ klf	_______ klf
	Haunch	_______ klf	_______ klf
	Girder	_______ klf	_______ klf
	S.I.P. Forms *	_______ klf	_______ klf
	Diaphragms & Lateral Bracing	_______ klf	_______ klf
	Utilities **	_______ klf	_______ klf
	TOTAL	_______ klf	_______ klf
SDL	Safetywalks or Sidewalks **	_______ klf	_______ klf
	Railing or Parapet & Screening	_______ klf	_______ klf
	Separate Wearing Surface **	_______ klf	_______ klf
	Future Wearing Surface ***	_______ klf	_______ klf
	TOTAL	_______ klf	_______ klf
LL	(HL-93)(Load Factor)		

TABLE 2.1.4

* If Applicable, Assume 0.004 ksf
** If Applicable
*** Assume 0.025 ksf for 2 inch asphalt overlay.

Notes:
1. If different girder configurations are required by design because of geometry or utilities, additional tables may be required.
2. The values in the above table shall be given to the nearest whole kip.

2.1.5 - MOMENT AND SHEAR TABLES ON CONTRACT PLANS

A Moment and Shear Table similar to that shown below shall appear on the plans for straight simple spans which are less than 50.0 feet in length. Quarter points shall be included for spans between 50.0 and 100.0 feet in length. Tenth points shall be shown for simple spans in excess of 100.0 feet. If values for moment and shear vary from girder to girder, separate tables shall be shown for each girder.

MOMENT AND SHEAR TABLE			**CL OF BEARINGS (UNFACTORED)**	**MIDSPAN (UNFACTORED)**
FASCIA GIRDERS	DL	MOMENT		
		SHEAR		
	SDL	MOMENT		
		SHEAR		
	LL(+)	MOMENT		
		SHEAR		
INTERIOR GIRDERS	DL	MOMENT		
		SHEAR		
	SDL	MOMENT		
		SHEAR		
	LL(+)	MOMENT		
		SHEAR		

TABLE 2.1.5(a)

Notes:
1. LL moments and shears include impact.
2. Moments are expressed in foot-kips.
3. Shears are expressed in kips.

A Moment & Shear Table similar to that shown below shall appear on the plans for all curved or continuous girder bridges. If values for moment and shear vary from girder to girder, separate tables shall be shown for each girder.

MOMENT AND SHEAR TABLE (UNFACTORED)			**CL BRG ABUT**	**.1L**	**.2L**	**.3L**	**.4L**	**.5L**	**.6L**	**.7L**	**.8L**	**.9L**	**CL BRG PIER**
GIRDER X	DL	MOMENT											
		SHEAR											
	SDL	MOMENT											
		SHEAR											
	LL(+)	MOMENT											
		SHEAR											
	LL(-)	MOMENT											
		SHEAR											

TABLE 2.1.5(b)

Notes:
1. LL moments and shears include impact.
2. Moments are expressed in foot-kips.
3. Shears are expressed in kips.

The above table shows intermediate values at 10th points. As an alternative, the designer may provide intermediate values at diaphragm locations. In either case, the interval shall be between 10.0 and 23.0 feet. Intermediate values shall coincide with locations shown on the Haunch Table, as discussed in Subsection 7.4.

2.2 – LOAD RATING OF STRUCTURES

The Title Sheet shall have a Controlling Load Rating Table for each structure (see sample below).

The table shall indicate the design method, controlling member(s), and the design live load.

MP XXX.XX LOAD RATING TABLE (LRFR)		
CONTROLLING MEMBER	INVENTORY LOAD RATING FACTOR	OPERATING LOAD RATING FACTOR
SPAN 1 – FASCIA STRINGER	1.20	1.83
SPAN 2 – INTERIOR STRINGER	1.02	1.32

HL-93 LIVE LOADING
INCLUDES 2 INCH FUTURE WEARING COURSE (25psf)

TABLE 2.2(a)

The class and design strength of all concrete, as well as all grades and yield strengths of structural steel and reinforcing steel used, shall be indicated on the General Notes sheet(s).

With the development of shallower superstructures used to increase vertical underclearance, the designs of some of these structures will be limited by allowable live load deflection instead of stress. The Thruway Authority limits the maximum live load deflection to L/1000 on all new structures, bridge replacements, and superstructure replacements, and L/800 on all major bridge rehabilitations. Although the safe load carrying capacity of these structures shall still clearly be defined by induced stress, the Controlling Load Rating Table shall also indicate the design live loading limitation imposed by live load deflection if it controlled the design.

Below is an example of a Load Rating Table that includes the live load deflection load rating.

MP XXX.XX LOAD RATING TABLE (LRFR)			
CONTROLLING MEMBER	INVENTORY LOAD RATING		OPERATING LOAD RATING
	CONTROLL-ING MODE	LOAD FACTOR	LOAD FACTOR
SPAN 1 – INTERIOR STRINGER	LIVE LOAD DEFLECTION	1.0	----
SPAN 1 – INTERIOR STRINGER	BENDING STRESS	1.21	1.87

HL-93 LIVE LOADING
INCLUDES 2 INCH FUTURE WEARING COURSE (25psf)

TABLE 2.2(b)

For bridge projects with a **NYSDOT** or **FHWA** share, the load rating shown on the Title Sheet shall not include the Future Wearing Surface. Load ratings for these projects must represent the “As Built” condition. This requirement does not exclude the future wearing surface from being included in the design of the bridge or the values shown in the Design Load Table (Table 2.1.4) or Moment and Shear Tables (Table 2.1.5(a) or 2.1.5(b)).