

# **PGSuper Tutorials**

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## **LRFR Load Rating with PGSuper**

**BridgeSight**

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<b>Title</b> PGSuper Tutorial – LRFR Load Rating	<b>Publication No.</b> BS050032010-1	
<p><b>Abstract</b>  This document provides a discussion of the new LRFR Load Rating features in PGSuper.</p>		
<b>Notes</b>		
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<b>Specification</b> AASHTO LRFD Bridge Design Specifications PGSuper Version 2.3		
<b>Original Publication Date</b> 05/03/2010	<b>Date of Latest Revision</b>	<b>Version</b> 1.0
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## Introduction

Load rating is an analysis used to determine the load carrying capacity of an existing bridge. Beginning October 1, 2010, all new and total replacement bridges designed by the LRFD Specifications must be rated by LRFR methods.

From FHWA Memorandum dated October 30, 2006 (<http://www.fhwa.dot.gov/BRIDGE/nbis/103006.cfm>), *For bridges and total replacement bridges designed by LRFD Specifications using HL-93, after October 1, 2010 Items 63, 64, 65, and 66 are to be computed and reported to the NBI as a RF based on LRFR methods using HL-93 loading.*

*Note: The MBE 2010 interim provisions, section C6A.1.1 defer the load rating requirements if a structure is designed using LRFD and the HL-93 loading until changes to the structure occur that would reduce the inventory rating below the design load level.*

PGSuper can perform the load rating analysis of the bridge superstructure in accordance with Section 6, Part A of the AASHTO Manual for Bridge Evaluation. These are commonly referred to as LRFR ratings.

PGSuper can perform load rating calculations for:

- Inventory
- Operating
- Legal Loads with Routine Commercial Traffic
- Legal Loads with Specialized Hauling Vehicles
- Permit Loads for routine or annual permits
- Permit Loads for special or limited crossing permits

Rating factors can be computed for positive moment, negative moment, shear, and flexural stresses.

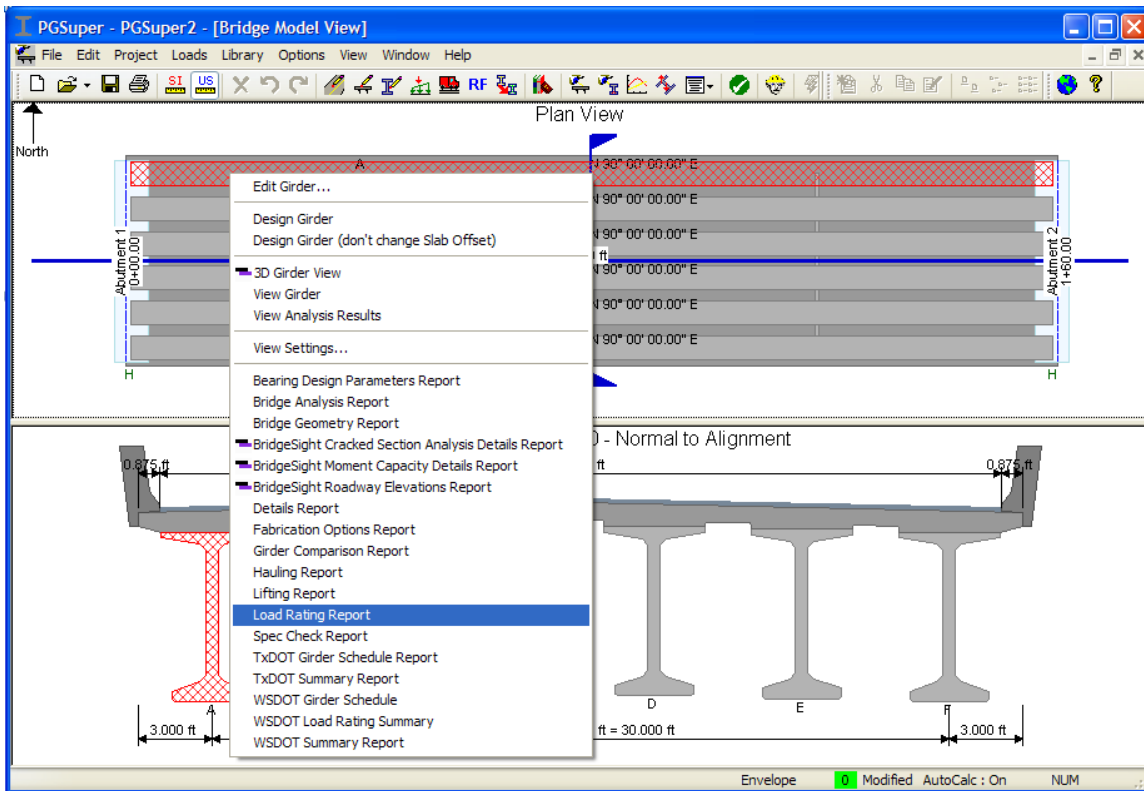
Load posting analysis is performed for legal load ratings with rating factors less than 1.0.

Load factors, limit state factors, dynamic load allowances, allowable stresses, condition factors, and system factors can be controlled by the bridge owner and the engineer.

## Load Rating Analysis

Like everything else in PGSuper, performing a load rating analysis is easy. All you have to do is open the Report View with the Load Rating Report.

To create a load rating report, right click on a girder line, and select Load Rating Report.



**Figure 1- Right click on a girder and select Load Rating Report**

The load rating analysis is based on the currently selected load rating criteria and load rating options. The load rating analysis can include:

- Design Load Rating – Inventory Level
- Design Load Rating – Operating Level
- Legal Load Rating – Routine Commercial Traffic
- Legal Load Rating – Specialized Hauling Vehicles
- Permit Load Rating – Routine/Annual Permit Rating Vehicles
- Permit Load Rating – Special/Limited Crossing Permit Rating Vehicles

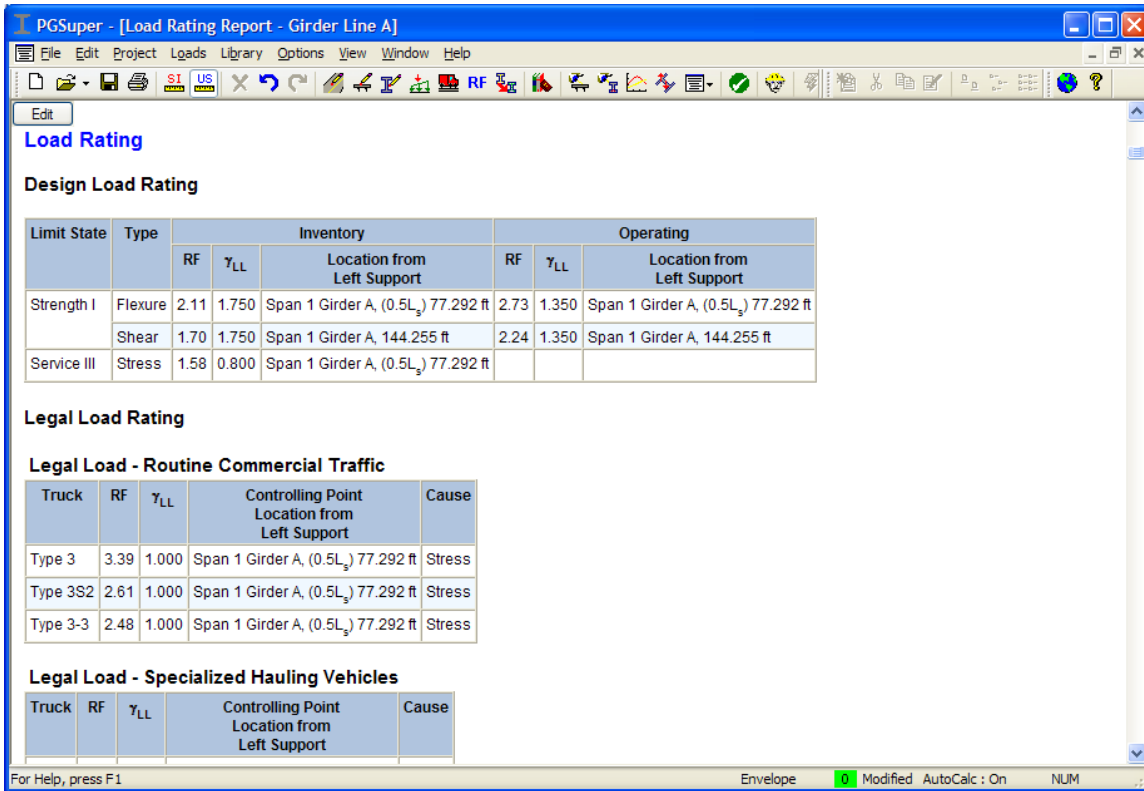


Figure 2 - Load Rating Summary

## Creating Load Rating Criteria

Load rating criteria is defined in the Load Rating Criteria library. The load rating criteria defines the specification that is used as the basis for the load rating criteria along with models for live load factors. Other parameters, such as allowable stresses are defined in the load rating options.

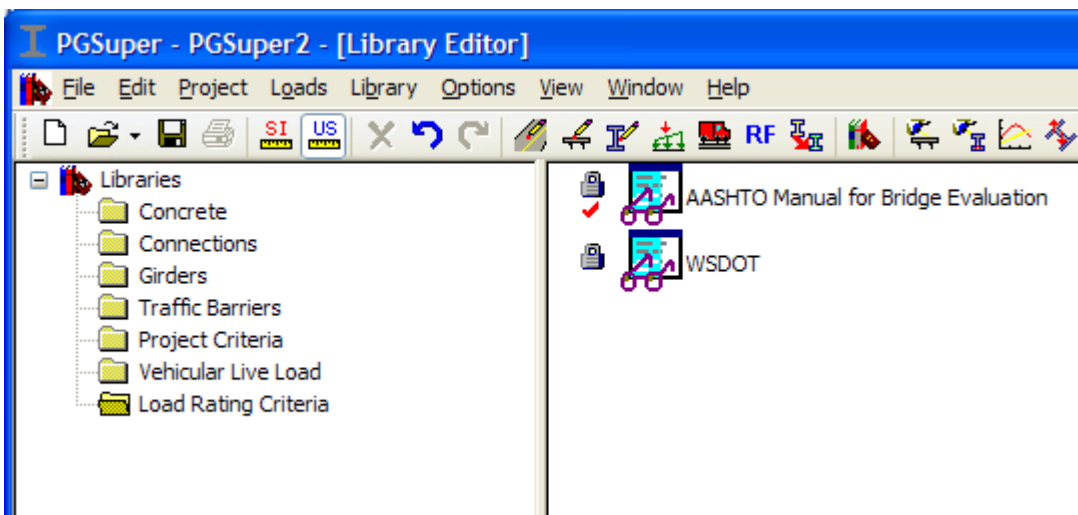
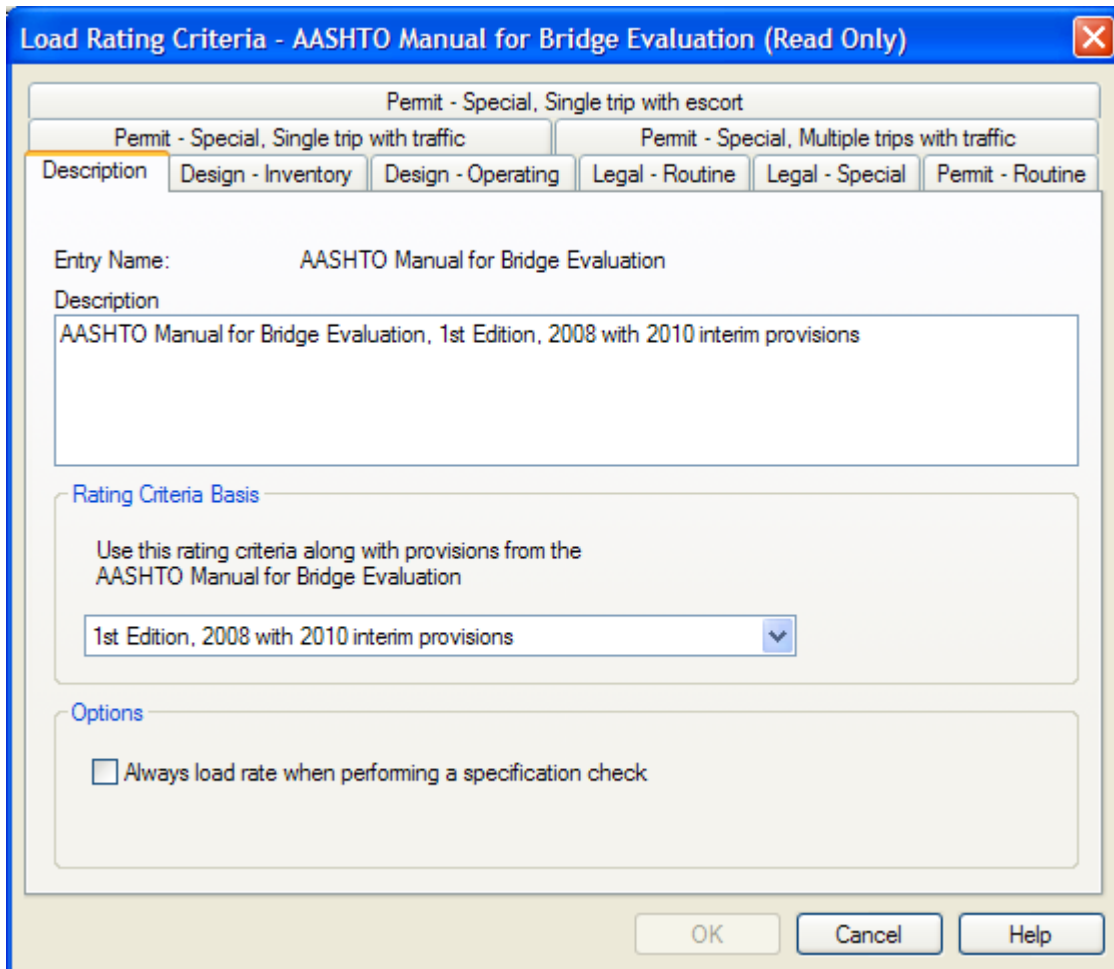


Figure 3 - Load Rating Criteria Library

Load rating criteria can be based on the AASHTO Manual for Bridge Evaluation 1<sup>st</sup> Edition 2008 or 1<sup>st</sup> Edition with 2010 interim provisions though there isn't any real difference between the two.



**Figure 4 - Load Rating Criteria description**

Live load factor models are defined for the rating analyses. A live load factor model can be as simple as a single value or as complex as a dual bilinear model that interpolates between ADTT and vehicle weight parameters. Live load factor models can be set up so that end users can override the values in the Load Rating Options. Figure 5 and Figure 6 illustrate live load factor models.

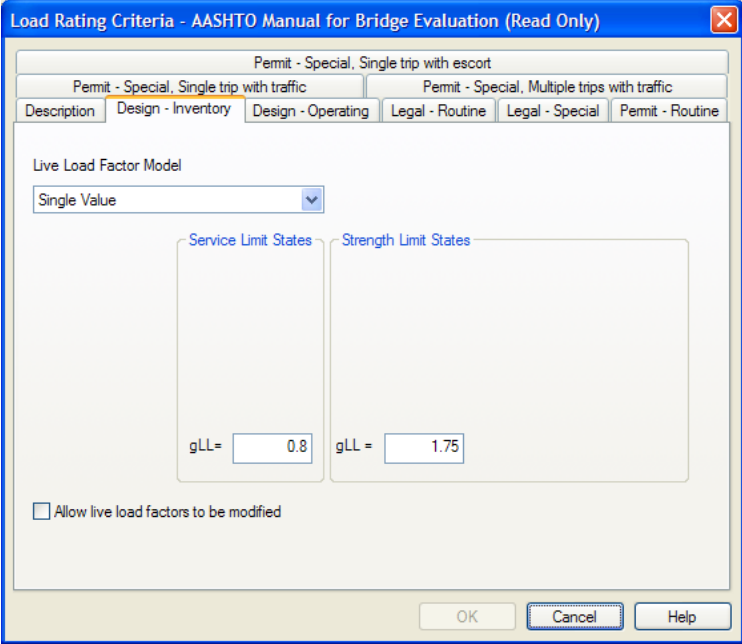


Figure 5 - Single value Live Load Factor

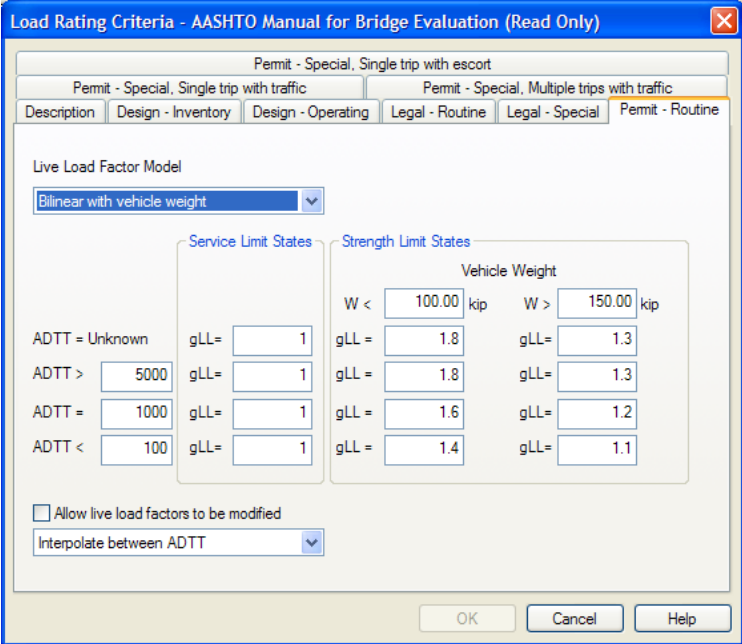


Figure 6 - Live Load Factors for Permit Load Ratings for Routine/Annual Permits

The live load factors defined in the MBE can be very complex. The permit live load factors given in Table 6A.4.5.4.2a-1 vary based on both ADTT and vehicle weight and can be linearly interpolated between the prescribed values.



Table 6A.4.5.4.2a-1—Permit Load Factors:  $\gamma_L$

Permit Type	Frequency	Loading Condition	$DF^a$	ADTT (one direction)	Load Factor by Permit Weight <sup>b</sup>	
					Up to 100 kips	≥150 kips
Routine or Annual	Unlimited Crossings	Mix with traffic (other vehicles may be on the bridge)	Two or more lanes	>5000	1.80	1.30
				=1000	1.60	1.20
				<100	1.40	1.10
<b>All Weights</b>						
Special or Limited Crossing	Single-Trip	Escorted with no other vehicles on the bridge	One lane	N/A	1.15	
	Single-Trip	Mix with traffic (other vehicles may be on the bridge)	One lane	>5000	1.50	
				=1000	1.40	
				<100	1.35	
	Multiple-Trips (less than 100 crossings)	Mix with traffic (other vehicles may be on the bridge)	One lane	>5000	1.85	
				=1000	1.75	
<100				1.55		

Some agencies find it undesirable to update load ratings on a route whenever ADTT values change. A conservative approach is to reduce the number of ADTT thresholds and to round the current ADTT up. The live load factors for the next highest ADTT are used rather than linearly interpolating between values. Figure 7 shows a comparison of the live load factor model defined by MBE and the simplified model used by WSDOT.

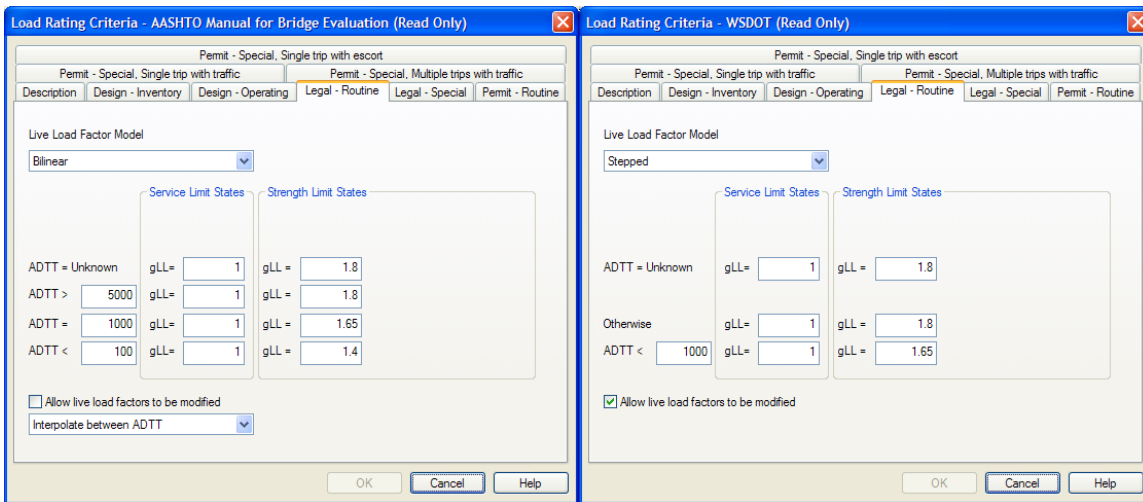


Figure 7 - Comparison of MBE and WSDOT Live Load Factors for Legal Load Ratings

## Condition Factors

Condition factors provide a reduction to account for the increased uncertainty in the resistance of a deteriorated member and the likely increase in future deterioration between inspection cycles (MBE 6A.4.2.3). Condition factors can be defined on the Condition and Rating tabs of the Girder Details dialog and the Bridge Description dialog. Each girder has a unique condition factor. The Bridge Description condition factor is applied to negative moment load ratings for the bridge deck.

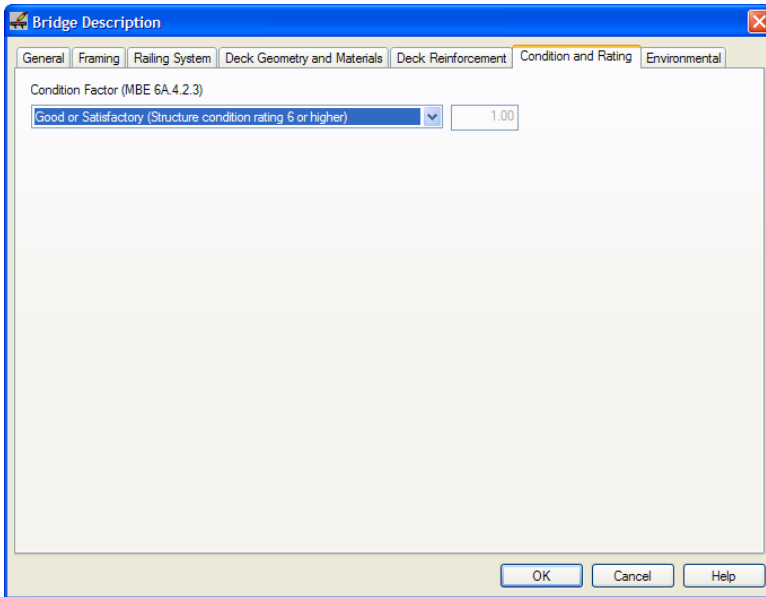


Figure 8 - Condition and Rating tab for the Bridge Description dialog

## Load Rating Options

The load rating options control the overall load rating analysis performed by PGSuper. Load rating options include Load Rating Criteria, System Factors, ADTT, Rating Types to perform, limit state load factors, live loads, dynamic load allowances, and controls for optional load rating computations.

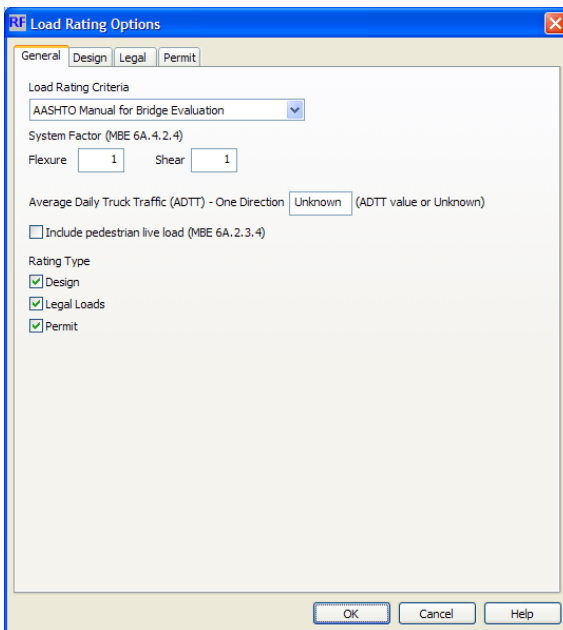


Figure 9 - General Load Rating Options

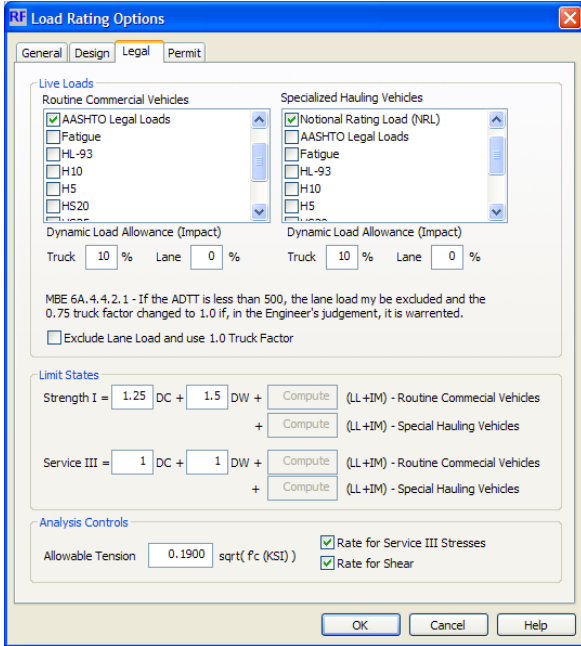


Figure 10 - Load Rating Options for Legal Load Ratings

## Load Posting Analysis

When the maximum legal load under State law exceeds the safe load capacity of a bridge, restrictive load postings are required. PGSuper performs a load posting analysis if the rating factor for the AASHTO Type 3, Type 3S2, Type 3-3, NRL, Type SU4, Type SU5, Type SU6, Type SU7, or user defined legal load is less than 1.0. The load posting analysis conforms to MBE 6A.8.3. PGSuper computes a Safe Load Capacity and a Safe Posting Load for the structure.



Legal Load - Specialized Hauling Vehicles				
Truck	RF	$\gamma_{LL}$	Controlling Point Location from Left Support	Cause
SU4	1.19	1.000	Span 1 Girder A, (0.5L <sub>s</sub> ) 77.292 ft	Stress
SU5	1.04	1.000	Span 1 Girder A, (0.5L <sub>s</sub> ) 77.292 ft	Stress
SU6	0.94	1.000	Span 1 Girder A, (0.5L <sub>s</sub> ) 77.292 ft	Stress
SU7	0.84	1.000	Span 1 Girder A, (0.5L <sub>s</sub> ) 77.292 ft	Stress
NRL	0.81	1.000	Span 1 Girder A, (0.5L <sub>s</sub> ) 77.292 ft	Stress

Load Posting (MBE 6A.8)				
Vehicle	Vehicle Weight (ton)	RF	Safe Load Capacity (ton)	Safe Posting Load (ton)
SU4	27	1.19	32	-
SU5	31	1.04	32	-
SU6	35	0.94	33	32
SU7	39	0.84	33	30
NRL	40	0.81	33	29

Figure 11 - Load Posting Analysis

# Permit Load Rating



Permit requests are easily load rated using PGSuper. The permit vehicle can be defined in the Vehicular Live Load Library and included in the load rating.

**Edit Vehicular Live Load - My Permit Vehicle**

Entry Name: My Permit Vehicle

Usage: Use for all actions at all locations

Load Type: Sum of Lane Load and Truck

Lane Load: 0.200 kip/ft for span length greater than 0.000 ft

**Truck Configuration**

Neglect axles that do not contribute to the maximum load effect under consideration

Axle #	Weight (kip)	Spacing (ft)
1	12	
2	21.5	10
3	21.5	4
4	22	6
5	21.5	16
6	21.5	4
7	22	6
8	21.5	14
9	21.5	4
10	22	6

Spacing is measured between axles.  
One axle may have a variable spacing.  
Enter variable spacing as min-max (e.g. 14-30)

Add Delete

OK Cancel Help

Figure 12 - Permit Live Load defined in Vehicular Live Load Library

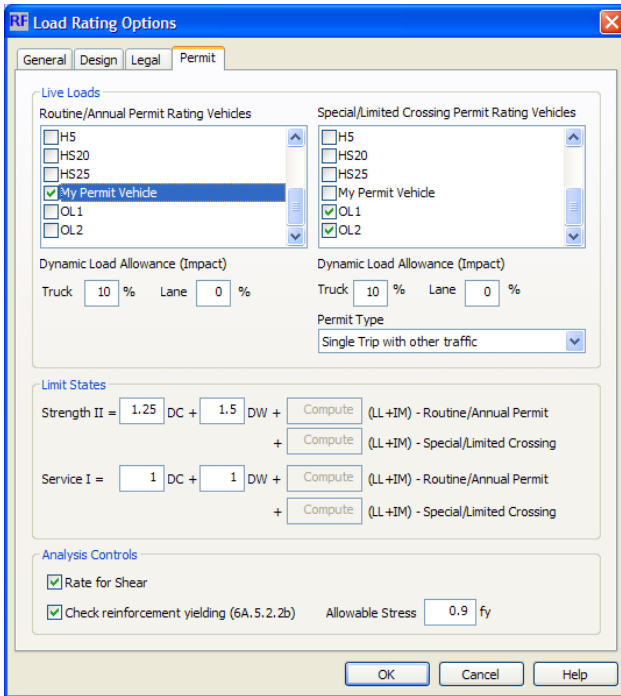


Figure 13 - Permit Live Load added to Load Rating Options

## Load Rating Analysis – Revisited

At the beginning of this tutorial you learned that performing a load rating analysis is as easy as viewing the Load Rating Report. This is absolutely true when your PGSuper Project is created from a template that is configured with load rating options consistent with an owner’s policies and criteria. In other cases, you may need to modify the load rating criteria and load rating options before creating the Load Rating Report.

The Load Rating Report contains a high level summary of the load rating analysis as well as the support details. By default, the most significant information is included in the Load Rating Report. Addition information can be included by enabling chapters in the Report Options dialog.

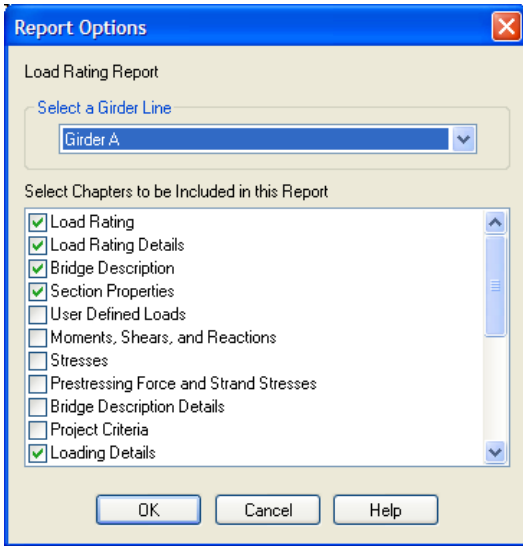


Figure 14 - Default Load Rating Report Chapters

## Customizing Load Rating Analysis and Reporting

PGSuper has an advanced software architecture that allows third parties to extend and enhance its capabilities. At BridgeSight Software, we can add new load rating capabilities and custom load rating reports to meet your needs. We can also enhance PGSuper with virtually any engineering feature you would like. For details, contact us at

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## Additional Information

Additional information on working with Libraries and Templates in PGSuper can in the PGSuper User's Guide. Interactive training videos can be viewed at [PGSuper.com](http://PGSuper.com).