

Development of Multimedia Resource and Short Courses for LRFR Rating

By

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Executive Summary

Multimedia technology is an important instrument in the training of graduate engineers. This multimedia package provides an exclusive background and an in-depth understanding of technological advances in the evaluation and rating of highway bridges. It gives guidelines and step-by-step illustrative examples using either hand calculations or VirtisTM software for the rating of different types of bridges according to the first edition of *The Manual for Bridge Evaluation* (2008). One advantage of the package is that it can be conveniently updated and modified to keep it useful for today's engineers.

The first edition of the *Manual for Bridge Evaluation* (MBE) was adopted by the AASHTO Highway Subcommittee on Bridges and Structures in 2005 and published in 2008. MBE combines the second edition of the *Manual for Condition Evaluation of Bridges* and the *Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges* into a single standard for bridge evaluation and rating. It provides three methods—ASR, LFR, and LRFR—for bridge rating without preference, and it is consistent with other major bridge codes adopted or being adopted, such as *AASHTO Standard Specifications for Highway Bridges* and *AASHTO LRFD Bridge Design Specifications*. LRFR incorporates design analysis and rating methods with different kinds of load factors and resistance factors, which are based on material properties and the known variability of applied loads.

This multimedia package teaches the basis on which engineers can evaluate highway bridges and calculate the rating factors. It includes illustrative examples and an overview of the strategic development of the structural code. This software is intended to be a self-training tool for inexperienced engineers who are interested in learning about the bridge-evaluation and bridge-rating procedures. It contains procedures and specifications for each possible situation together with detailed examples and illustrations. It is a time-saving, user-friendly, reliable way of learning.

Section 1

Introduction

The main goal of the LRFR multimedia package is to provide a practical introduction and in-depth understanding of the rating procedures. This package can be used to train engineers, architects, designers, and personnel who are in charge of the management, evaluation, rating, maintenance, and reconstruction of bridges. It is a self-training and time-saving tool. The package includes instructions of procedures of bridge evaluation and rating based on the *Manual for Bridge Evaluation* and several examples from which the user can get an overview of the evaluation and rating process.

Load and Resistance Factor Rating (LRFR) is a rating method providing uniform reliability for load effects and structure resistances. The *Manual for Bridge Evaluation* provides not only the specifications for bridge management and evaluation but also the procedures for three bridge-rating methods: ASR, LFR, and LRFR. Load and Resistance Factor Design specifications are fully adopted nationwide as a single design method and procedure, so many states have been working to implement LRFR, which is the parallel rating method to LRFD.

For new bridges designed by LRFD after October 1, 2010, the operating rating and inventory rating are to be computed and reported to the NBI as an RF based on LRFR methods using HL-93 loading. An introduction comparing the three rating procedures (ASR, LFR, and LRFR) is included on the CD.

The CD package offers a tutorial that employs a wide range of multimedia, including hyperlinks and high-resolution graphics. To ensure the use of this multimedia package, it will be machine adaptable and designed to run on different operating systems. It is a self-training and time-saving tool. One advantage of this package is that it is easily updated.

Section 2 Methodology

An extensive review of the existing literature and information available on bridge rating was performed. Since LRFR is a new topic, step-by-step rating procedures were included in the package for better understanding.

The package is divided into four parts. The first part, LRFR Basic Knowledge, has eight sections. Each section contains specific equations, tables, and diagrams of relevance. The second part, Illustrative Examples, has five sections. These sections are composed of nine rating procedure examples using hand calculations. The third part, Virtis™ Rating Examples, consists of four rating examples using Virtis™. The fourth part, Search Engine, provides a platform for users to look up technical definitions related to LRFD and LRFR and to search for a topic included in the package. To utilize the benefits of a multimedia product to the fullest, hyperlinks were created in all the sections as well as the design examples to quickly access the required details. This package was created using Macromedia Dreamweaver MX.

For updates to the multimedia package according to the MBE, including recommendations from ALDOT (Alabama Department of Transportation), the PI's contact information is included in the package.

Section 3 CD-ROM Description

This multimedia package includes a homepage together with section pages and basic theory concepts. It also provides the user with nine manual-calculation bridge-rating examples, four Virtis™ rating examples, and several links to helpful bridge-evaluation and -rating resources. It also includes a search-engine webpage that provides many definitions. The following is a description of these sections.

3.1 Homepage

The homepage explains the goals and advantages of the software and provides an overview of the package's contents. This multimedia package is a self-training tool providing information on MBE and bridge-rating procedures (see Figure 3-1). In the left column are dropdown lists that provide links to the package contents.



Figure 3-1. The homepage

3.2 Introduction

The introduction page provides brief information about bridge rating and LRFR. This page answers several questions about bridge rating: *what are specifications and codes about load rating? what is load rating for highway bridges?* and so on. It introduces the user to general knowledge about bridge rating (see Figure 3-2).



The screenshot shows the 'Load and Resistance Factor Rating' website. The header features a navigation bar with links: Home, Introduction (highlighted), Terminology, Theory, Reliability, General, and Contact Us. Below the navigation bar is a sidebar menu with sections: LRFR Basic Knowledge (Sections >>>), Illustrative Examples (Sections >>>), Virtis Rating Examples (Sections >>>), and Search Engine (Search in >>>). The main content area is titled 'Introduction' and contains the following text:

1. Specifications and codes about Load Rating.
The *Manual for Bridge Evaluation* (MBE), First Edition/2008 was adopted by the AASHTO Highways Subcommittee on Bridges and Structures in 2005. The MBE combines the *Manual for Condition Evaluation of Bridges*, Second Edition/2000 and its 2001 and 2003 Interim Revisions with the *Guide Manual for Condition Evaluation and Load and Resistance factor Rating (LRFR) of highway Bridges*, First Edition and its 2005 Interim Revisions. Revisions based on approved agenda items from annual Subcommittee meetings in 2007 and 2008 are also incorporated into the MBE. Furthermore, this manual is incorporated with the AASHTO Bridge Design Specifications which include 1) AASHTO *Standard Specification for Highway Bridge 17th Edition, 2002*, 2) AASHTO *Load and Resistance factor Design Bridge Design Specification 4th Edition, 2007*.

2. What is Load Rating for highway bridges?
Load Rating, permitting and posting are three separate procedures. The load rating process is a component of the inspection process and consists of determining if specific legal or overweight vehicles can safely cross the bridge and determining if a bridge needs to be restricted and the level of posting required. Load Rating is usually expressed as a factor called rating factor (*RF*) of a defined vehicle or as a gross tonnage for a defined vehicle axle configuration.

3. Why do we need the load rating for highway bridges?
The purpose of bridge ratings is to provide a measure of a bridge's ability to carry a specific live load in terms of a simple factor which is referred to as the rating factor (*RF*). These specific load ratings could be used by bridge owners to aid in decisions about the need for load posting, bridge strengthening, overweight load allowances as well as bridge closures. Load ratings are routinely reported to the NBI (National Bridge Inventory) for national bridge administration and are also used in local bridge management systems.

4. What is the basis of the load rating?

Figure 3-2. The Introduction page answers FAQs

3.3 Terminology

The terminology page provides basic definitions about bridge rating and LRFR (see Figure 3-3). (More comprehensive terminologies and definitions about bridge design and rating are found in Section 4, Search Engine.)

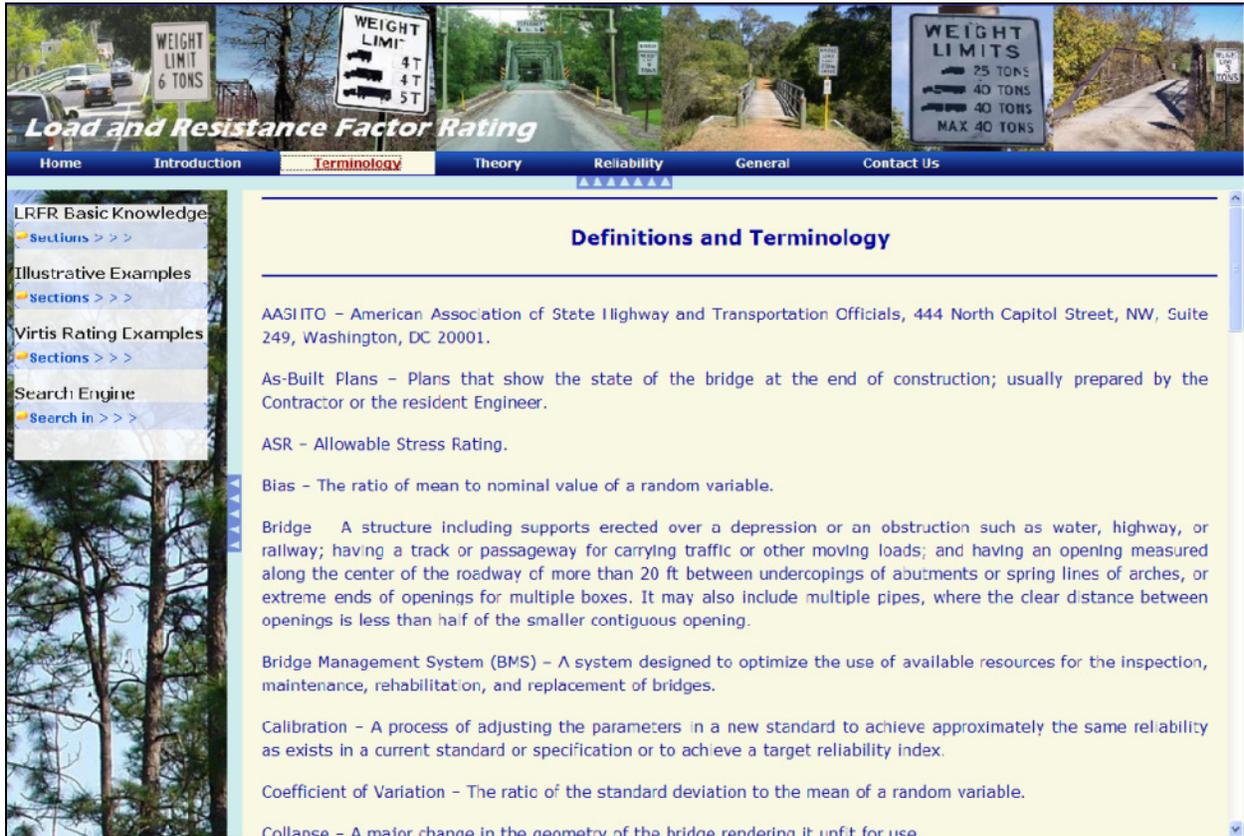


Figure 3-3. Definitions and terminologies

3.4 Theory

On the theory page, the general theory behind three rating methods—Allowable Stress Rating, Load Factor Rating, and Load and Resistance Rating—is discussed (see Figure 3-4).

The screenshot shows a web browser displaying the 'Load and Resistance Factor Rating' website. The page title is 'Load and Resistance Factor Rating' and the navigation menu includes Home, Introduction, Terminology, Theory (highlighted), Reliability, General, and Contact Us. The main content area is titled 'Theory' and contains the following sections:

LRFR Bridge Rating

1. Introduction

There are three load-rating procedures that are consistent with the load and resistance factor philosophy for the load capacity evaluation of in-service bridges:

- Design load rating (first level evaluation)
- Legal load rating (second level evaluation)
- Permit load rating (third level evaluation)

Each procedure is geared to a specific live load model with specially calibrated load factors aimed at maintaining a uniform and acceptable level of reliability in all evaluations.

The load rating is generally expressed as a rating factor for a particular live load model, using the general load-rating equation as follows.

2. General Load-Rating Equation

The following general expression shall be used in determining the load rating of each component and connection subjected to a single force effect (i.e., axial force, flexure, or shear):

$$RF = \frac{C - (\gamma_{DC})(DC) - (\gamma_{DW})(LW) \pm (\gamma_r)(P)}{(\gamma_{LL})(LL, IM)}$$

For the Strength Limit States:
 $C = \phi_c \phi_s \phi_{Rn}$

Where the following lower limit shall apply:
 $\phi_c \phi_s \geq 0.85$

For the Service Limit States:

Figure 3-4. Basic theory behind rating methods

3.5 Reliability

The reliability page provides history behind bridge evaluations and the relation between reliability theory and LRFR ratings (see Figure 3-5).



Figure 3-5. LRFR ratings and reliability theory

3.6 General

This page presents the introduction of bridge ratings and several rating methods (see Figure 3-6).



Figure 3-6. Background and comparisons

3.7 Description of Parts

3.7.1 LRFR Basic Knowledge

The following eight sections and their contents are from the first edition of the *Manual for Bridge Evaluation* (2008).

3.7.1.1 Introduction Section 1 introduces four topics: 1) the purpose of bridge evaluation and rating, 2) the scope of bridge evaluation and rating to give users a general introduction for the contents in the package, 3) applicability to inform users which kind of highway bridge is considered in this package, and 4) quality measures to emphasize the importance of quality control during bridge evaluation (see Figure 3-7).



The image is a screenshot of a web browser displaying the 'LRFR Basic Knowledge' website. The page title is 'Load and Resistance Factor Rating'. The navigation menu includes: Home, Introduction, Terminology, Theory, Reliability, General, and Contact Us. The 'Reliability' tab is active. The main content area is titled 'Section 1 INTRODUCTION'. Below the title is a 'Quick Links' section with four items: 1.1 Purpose, 1.2 Scope, 1.3 Applicability, and 1.4 Quality measures. The '1.1 PURPOSE' section contains two paragraphs: the first states that the *Manual for Bridge Evaluation* (MBE), First Edition/2008 serves as a standard and provides uniformity in procedures and policies for determining the physical condition, maintenance needs, and load capacity of the nation's highway bridges; the second states that the goal of this package is to provide a practical introduction of MBE and in-depth understanding of new technological advances in the rating as well as procedures of evaluation of concrete, steel and timber highway bridges. The '1.2 SCOPE' section contains two paragraphs: the first states that the contents of this package have been divided into eight sections, with each section representing a distinct phase of an overall bridge inspection and evaluation program; the second states that Section 1 contains Introductory and background Information on the maintenance Inspection of bridges. Key components of a comprehensive bridge file are defined in Section 2. The record of each bridge in the file provides the foundation against which changes in physical condition can be measured. Changes in condition are determined by field inspections. A bridge management system is an effective tool in allocating limited resources to bridge related activities. An overview of bridge management systems is included in Section 3. The types and frequency of field inspections are discussed in Section 4, as are specific Inspection techniques and requirements. Conditions at a bridge

Figure 3-7. Introduction page for Section 1

3.7.1.2 Bridge Files This section describes bridge files, inventory data, inspection data, and data collected for bridge load rating (see Figure 3-8).

The data required for condition rating and load-rating procedure are:

1. Bridge Condition Rating. Document the results of the bridge-condition inspection, including observed conditions and recommended maintenance operations or restrictions regarding the deck, superstructure, substructure, and channel.
2. Load Rating. A record should be kept of the calculations to determine the safe load capacity of a bridge and, where necessary, the load limits for posting. A general statement of the results of the analysis with notes of which members were found to be weak, and any other modifying factors that were assumed in the analysis, should be given. See Section 6 for the load-rating procedures.



Figure 3-8. Bridge files

3.7.1.3 Bridge Management Systems Section 3 provides information about bridge management systems (BMSs): 1) the objectives of BMS, 2) the components of a bridge management system, and 3) national bridge management systems (see Figure 3-9).

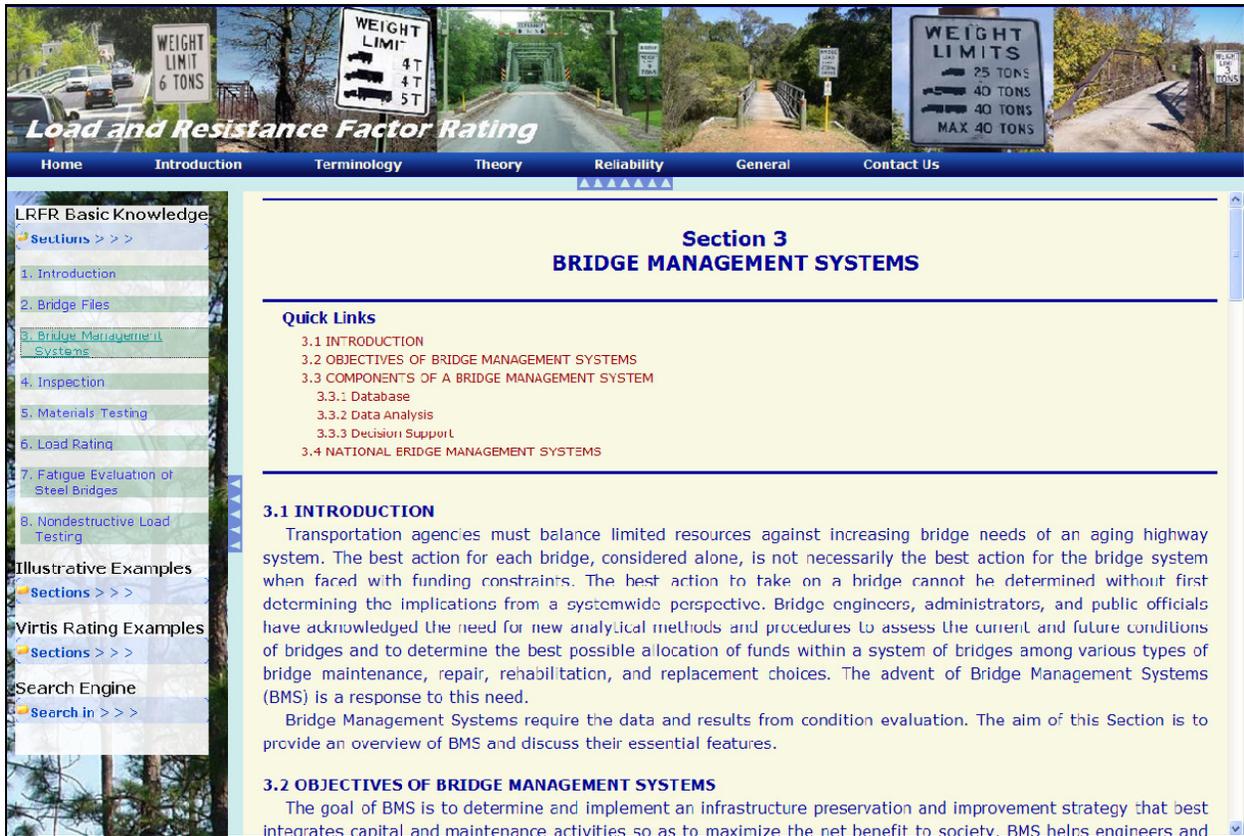


Figure 3-9. Bridge management systems

3.7.1.4 Inspection Section 4 introduces several aspects of bridge inspection: types of inspection, frequency of inspection, inspection safety, inspection procedures, and so on. Subsection 3 also provides inspection requirements for fatigue-prone members and fracture-critical members (see Figure 3-10).

In inspection-procedure specifications, the members of bridges are grouped into three types: substructure, superstructure, and decks. The MBE gives detailed procedures for inspecting each type of bridge member.



Figure 3-10. Inspection

3.7.1.5 Material Testing Section 5 provides knowledge related to material testing. It introduces field-test methods for concrete, steel, and timber bridges. It also describes field-sampling requirements and laboratory testing (see Figure 3-11).

The screenshot shows a website interface for 'Load and Resistance Factor Rating'. At the top, there are several photographs of bridges with weight limit signs. Below the photos is a navigation bar with links: Home, Introduction, Terminology, Theory, Reliability, General, and Contact Us. On the left side, there is a sidebar menu with sections like 'LRFR Basic Knowledge', 'Sections >>>', '1. Introduction', '2. Bridge Files', '3. Bridge Management Systems', '4. Inspection', '5. Materials Testing', '6. Load Rating', '7. Fatigue Evaluation of Steel Bridges', '8. Nondestructive Load Testing', 'Illustrative Examples', 'Virtis Rating Examples', and 'Search Engine'. The main content area is titled '5.4 LABORATORY TESTS' and contains the following text:

stress resulting from the repair.

5.4 LABORATORY TESTS

To supplement field tests and observations, there are many laboratory tests which have been standardized and used routinely in the evaluation of materials used in bridges. Tables 5.4-1, 5.5-1, and 5.5-2 list the ASTM and AASHTO standards governing the laboratory testing of concrete, steel, and timber components, respectively.

Laboratory tests should be conducted by testing laboratories familiar with the AASHTO, ASTM, and Bridge Owner standards to be employed.

Table 5.4-1—Standard ASTM and AASHTO Test Methods for Concrete for Use in the Laboratory

Designation ^a	Title
C 39/T 22	Test Method for Compression Strength of Cylindrical Concrete Specimens
C 1804/ T 176	Test Method for Cement Content of Hardened Portland Cement Concrete
C 174/T 148	Method of Measuring Length of Drilled Concrete Cores
C 457	Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete
C 469	Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
C 496	Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
C 617/T 23	Method of Capping Cylindrical Concrete Specimens
C 642	Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete
C 666/T 16	Test Method for Resistance of Concrete to Rapid Freezing and Thawing
C 856	Recommended Practice for Petrographic Examination of Hardened Concrete
T 259	Method of Test for Resistance of Concrete

Figure 3-11. Material testing

3.7.1.6 Load Rating This section provides the requirements and procedures of three rating methods: Allowable Stress Rating (ASR), Load Factor Rating (LFR), and Load and Resistance Factor Rating (LRFR) (see Figure 3-12).

Part 6A covers LRFR and Part 6B covers ASR/LFR. These two subsections detail requirements and procedures for all three methods.



Figure 3-12. Load rating

3.7.1.7 Fatigue of Steel Bridges This section covers a special topic: fatigue of steel bridges. It provides the inspection requirements for steel bridges and introduces a method to estimate finite fatigue life (see Figure 3-13).



Figure 3-13. Fatigue of steel bridges

3.7.1.8 Nondestructive Load Testing This section contains provisions for nondestructive load testing. Load testing is the observation and measurement of the response of a bridge subjected to controlled and predetermined loadings without causing changes in the elastic response of the structure. Load tests can be used to verify both component and system performance under a known live load and provide an alternative evaluation method to analytically computing the load rating of a bridge (see Figure 3-14).

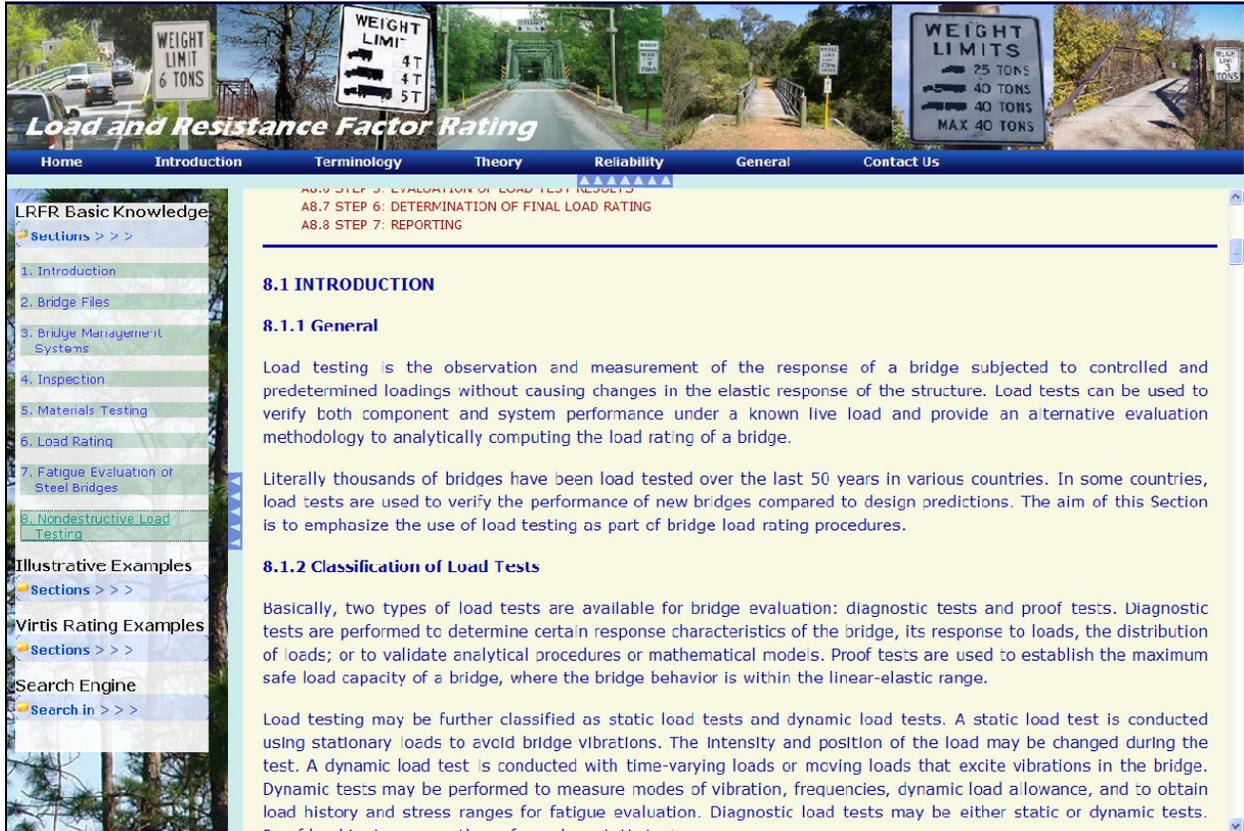


Figure 3-14. Nondestructive load testing

3.7.2 Illustrative Examples

The following five parts illustrate bridge rating using manual calculations.

3.7.2.1 Introduction and General Information In this section several aspects about rating procedure are detailed, such as background knowledge and loads used in load rating (see Figure 3-15).



Figure 3-15. Introduction and general information about bridge rating

3.7.2.2 Reinforced-Concrete Bridge-Rating Examples This section contains two typical concrete superstructure bridge-rating examples. The first is a reinforced concrete T-beam bridge. The interior beam is rated with ASR, LFR, and LFRF respectively (see Figure 16). The second example is a general outline of the procedure (see Figure 17). The second example intended to be a generic overview of the rating process.

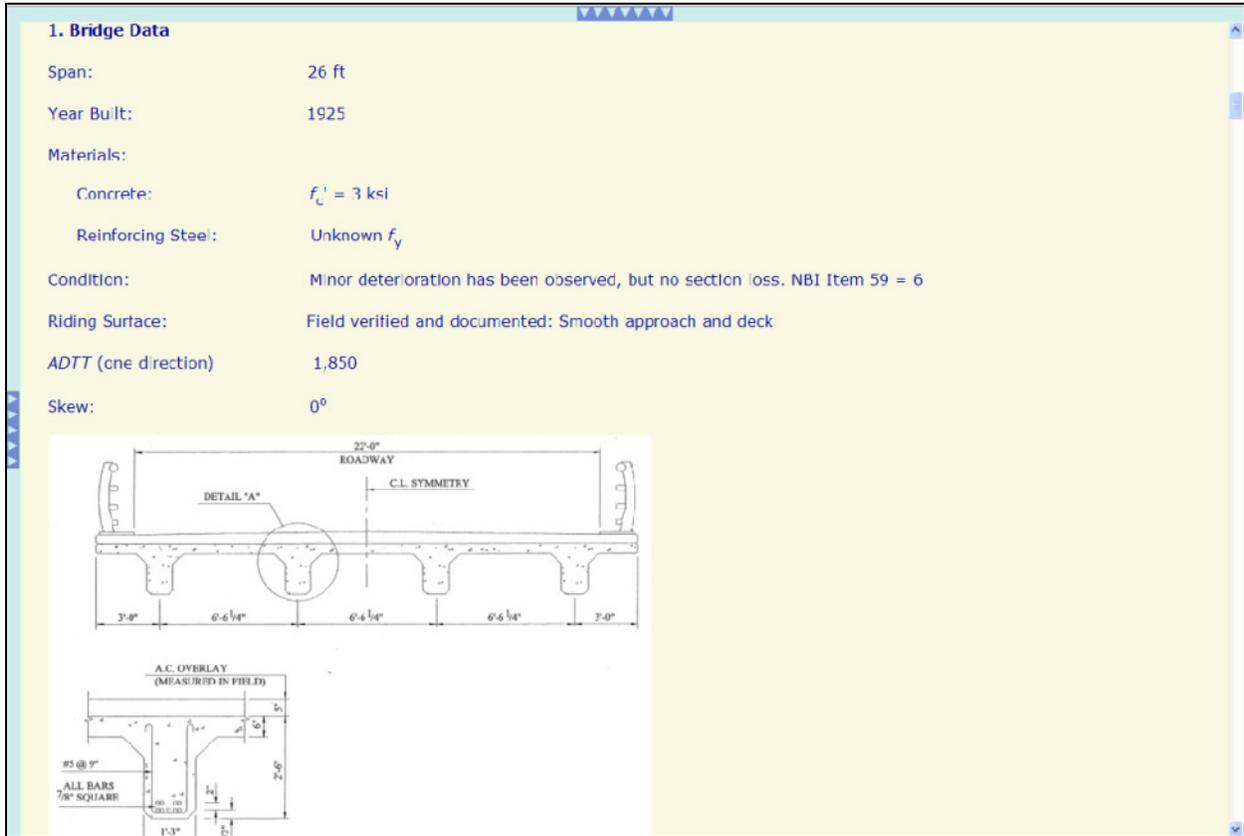


Figure 3-16. Reinforced-concrete bridge-rating example #1

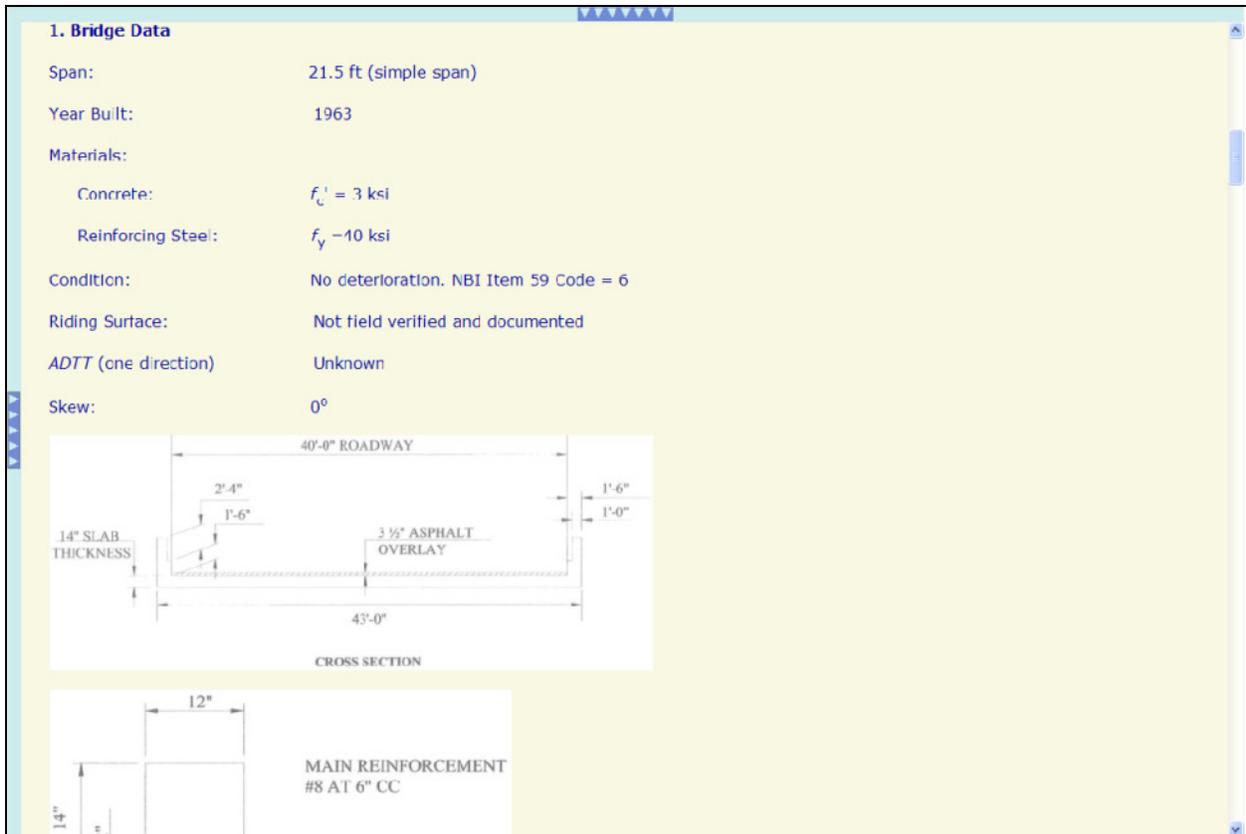


Figure 3-17. Reinforced-concrete bridge-rating example #2

3.7.2.3 Prestressed Concrete Bridge Rating Examples This section uses two prestressed-concrete bridges as rating examples. The first is a simple span prestressed-concrete I-girder bridge (see Figures 3-18). The second is a prestressed-concrete adjacent box-beam bridge (see Figures 3-19).

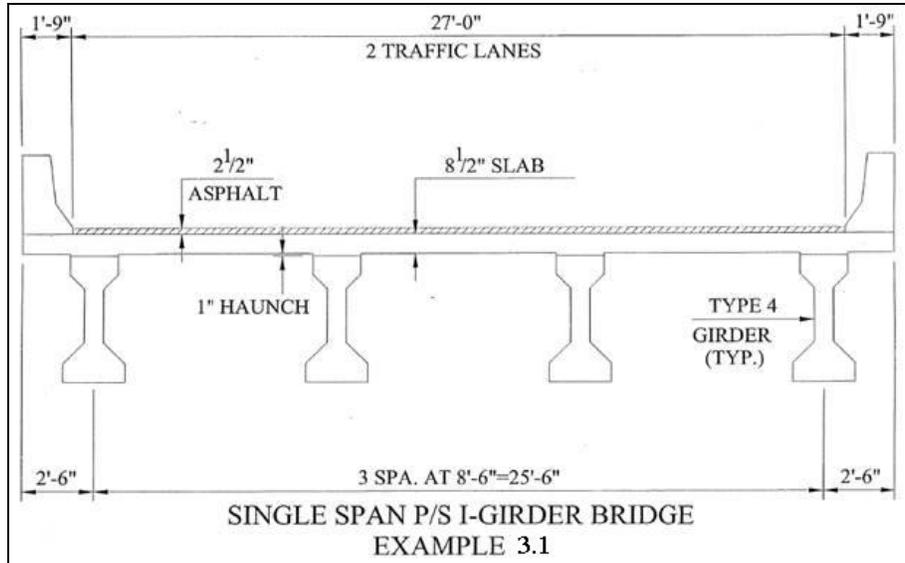


Figure 3-18a. Prestressed-concrete bridge-rating example #1 cross section

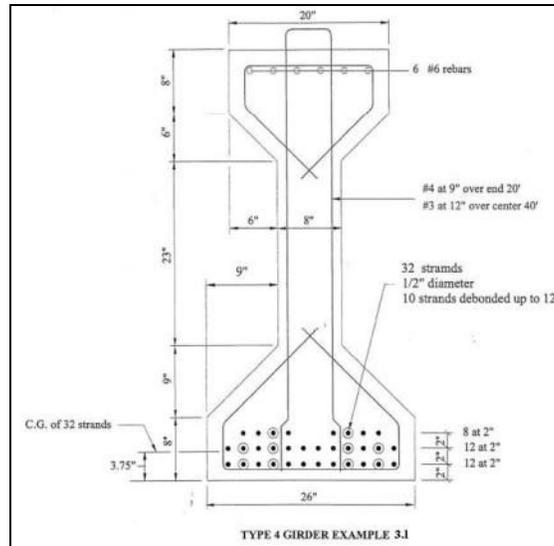


Figure 18b. Prestressed-concrete bridge-rating example #1 I-girder

1. Bridge Data	
Span:	80 ft (Total Length = 81 ft)
Year Built:	1985
Materials:	
Concrete:	$f'_c = 4$ ksi (Deck) $f'_c = 5$ ksi (P/S Beam) $f'_{ci} = 4$ ksi (P/S Beam at transfer)
Prestressing Steel:	$\frac{1}{2}$ in. diameter, 270 ksi, Low-Relaxation Strands $A_{ps} = 0.153$ in. ² per strand 32 prestressing strands; ten are debonded over the last 12 ft on each end
Stirrups:	#4 at 9 in. over end 20 ft #3 at 12 in. over center 40 ft
Compression Steel:	six #6 Grade 60
Condition:	No Deterioration, NBI Item 59 Code=6
Riding Surface:	Minor surface deviations (Field verified and documented)
ADTT (one direction)	5,000
Skew:	0°
Effective Flange Width	b_c LRF Design 4.6.2.6.1
Minimum of:	
i)	L)

Figure 18c. Page for prestressed-concrete bridge-rating example #1

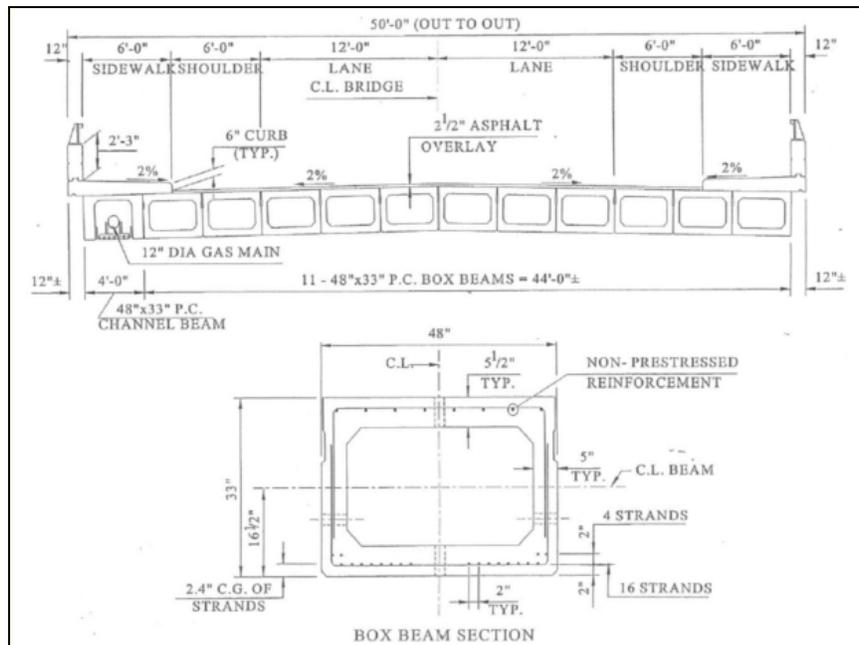


Figure 19a. Prestressed-concrete bridge-rating example #2 cross section

Example 3.2

P/S CONCRETE ADJACENT BOX-BEAM BRIDGE: DESIGN LOAD AND PERMIT LOAD RATING OF AN INTERIOR BEAM

Quick Links

- 1 Bridge Data**
 - 1.1 Section Properties
- 2 Dead Load Analysis—Interior Beam**
 - 2.1 Components and Attachments, *DC*
 - 2.2 Wearing Surface and Utilities, *DW*
- 3 Live Load Analysis—Interior Girder**
 - 3.1 Compute Live Load Distribution Factors for an Interior Beam (LRFD Design Table 4.6.2.2b-1)
 - 3.1.1—Distribution Factor for Moment
 - 3.2 Maximum Live Load (HL-93) Moment at Midspan
- 4 Compute Nominal Flexural Resistance**
- 5 Maximum Reinforcement (6A.5.6)**
- 6 Minimum Reinforcement (6A.5.7)**
 - 6.1 Determine Effective Prestress Force, P_{pe}
 - 6.1.1—Loss Due to Elastic Shortening, Δf_{pES} (LRFD Design 5.9.5.2.3a)
 - 6.1.2—Approximate Lump Sum Estimate of Time-Dependent Losses, Δf_{pLT} (LRFD Design 5.9.5.3)
 - 6.1.3—Total Prestress Losses, Δf_p
- 7 General Load-Rating Equation (6A.4.2)**

Figure 19b. Page for prestressed-concrete bridge-rating example #2

3.7.2.4 Examples for Rating Steel Bridges This section contains rating examples for four typical steel bridges. The first is a simple span composite-steel stringer bridge (see Figure 3-20). The second is a four-span continuous straight welded plate girder bridge (see Figure 3-21). The third is a through Pratt truss bridge (see Figure 3-22). The fourth is a two-girder steel bridge (see Figure 3-23).

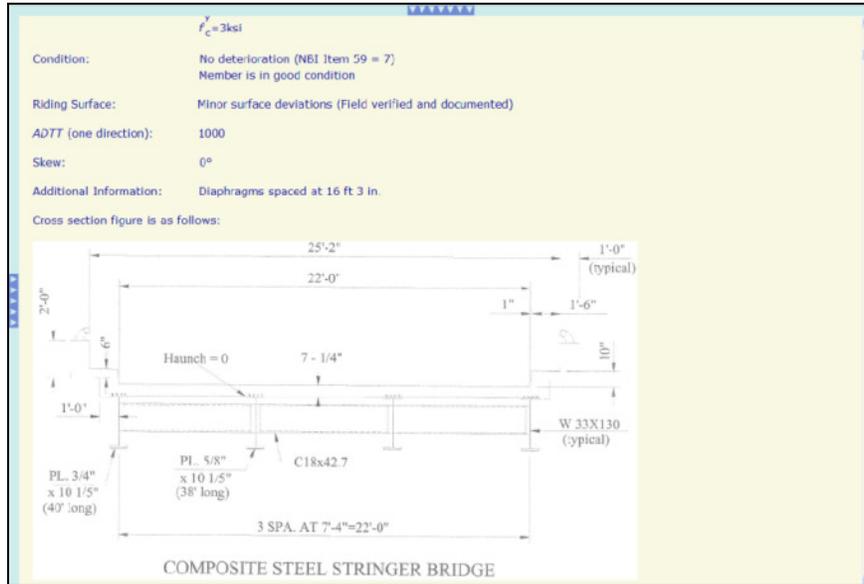


Figure 3-20. Example #1 for rating steel bridges

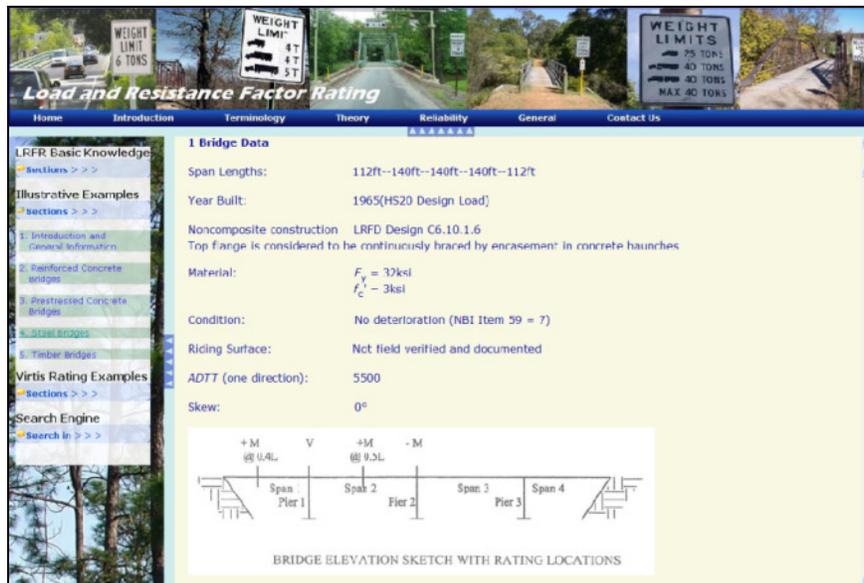


Figure 3-21. Example #2 for rating steel bridges

LRFR Basic Knowledge

- Sections >>>

Illustrative Examples

- Sections >>>

1. Introduction and General Information
2. Reinforced Concrete Bridges
3. Prestressed Concrete Bridges
4. Steel Bridges
5. Timber Bridges

Virtis Rating Examples

- Sections >>>

Search Engine

- Search in >>>

8.3 Diagonal D1
8.4 Vertica V1
9 Summary of Rating Factors
10 References

1 Bridge Data

Span Lengths: 175ft (single span, pin-connected truss)

Year Built: 1909

Noncomposite construction LRFD Design C6.10.1.6
Top flange is considered to be continuously braced by encasement in concrete haunches

Material: Steel $F_y = 32$ ksi
(nominal yield by testing) $F_u = 65.4$ ksi (nominal ultimate by testing)

Condition: No deterioration. NBI Item 59 Code = 7

Riding Surface: Net field verified and documented

ADTT (one direction): Unknown

Skew: 0°

2 Member Properties

Member	Section	A, in ²	r, in.
Top Chord TC4 Riveted	Built-up Section 2 Web Pl. $21 \times \frac{1}{2}$ 2 Bottom Angle $5 \times 3\frac{1}{2} \times \frac{3}{8}$ 2 Top Angle $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$ Top Cover Plate $27 \times \frac{1}{2}$	55.3	9.1
Bottom Chord BC4	6 Eyebars 8×1	48.0	—
Diagonal D1	2 Eyebars $8 \times 1\frac{1}{2}$	24.0	—

Figure 3-22. Example #3 for rating steel bridges

LRFR Basic Knowledge

- Sections >>>

Illustrative Examples

- Sections >>>

1. Introduction and General Information
2. Reinforced Concrete Bridges
3. Prestressed Concrete Bridges
4. Steel Bridges
5. Timber Bridges

Virtis Rating Examples

- Sections >>>

Search Engine

- Search in >>>

Load and Resistance Factor Rating

Home Introduction Terminology Theory Reliability General Contact Us

CROSS SECTION

Figure 3-23. Example #4 for rating steel bridges

3.7.2.5 An Example for Rating Timber Bridges This section contains an example for rating a timber bridge with ASR/LFR and LRFR methods (see Figure 3-24). The rating process is presented procedurally. The outline and summary of the rating procedure is also shown in the example. The users of this section may get a thorough and clear understanding of the rating process for timber bridges.

LRFR Basic Knowledge
Sections >>>

Illustrative Examples
Sections >>>

1. Introduction and General Information

2. Reinforced Concrete Bridges

3. Prestressed Concrete Bridges

4. Steel Bridges

5. Timber Bridges

Virtis Rating Examples
Sections >>>

Search Engine
Search In >>>

1 Bridge Data

Span:	17 ft 10 in.
Year Built:	1964
Year Reconstructed:	1967
Material:	Southern Pine No. 2
Condition:	No deterioration. NDI Item 59 Code – 6
Riding Surface:	Unknown condition
Traffic:	Two Lanes
ADTT (one direction):	150
Skew:	0

Figure 1-1 Partial Cross Section of Deck

2 Dead Load Analysis—Interior Stringer in Flexure

Figure 3-24. Example for rating a timber bridge

3.7.3 Virtis™ Rating Examples

This part contains four sections. The first section is introduction to Virtis™. The other three are Virtis™ bridge-rating examples.

3.7.3.1 Introduction to Virtis™ An introduction to AASHTO's Virtis™ software for bridge rating is presented in this section (see Figure 3-25). This section describes several features of this rating software.



Figure 3-25. Introduction to Virtis™

3.7.3.2 Virtis™ Reinforced Concrete Bridge Rating Example This section includes one rating example for a typical reinforced-concrete bridge using Virtis™ (see Figure 3-26). The rating process is presented procedurally with detailed pictures of Virtis™ operations. The outline and summary of the rating procedure is also shown. The users of this section may get a general understanding of the rating process for reinforced-concrete bridges using Virtis™.

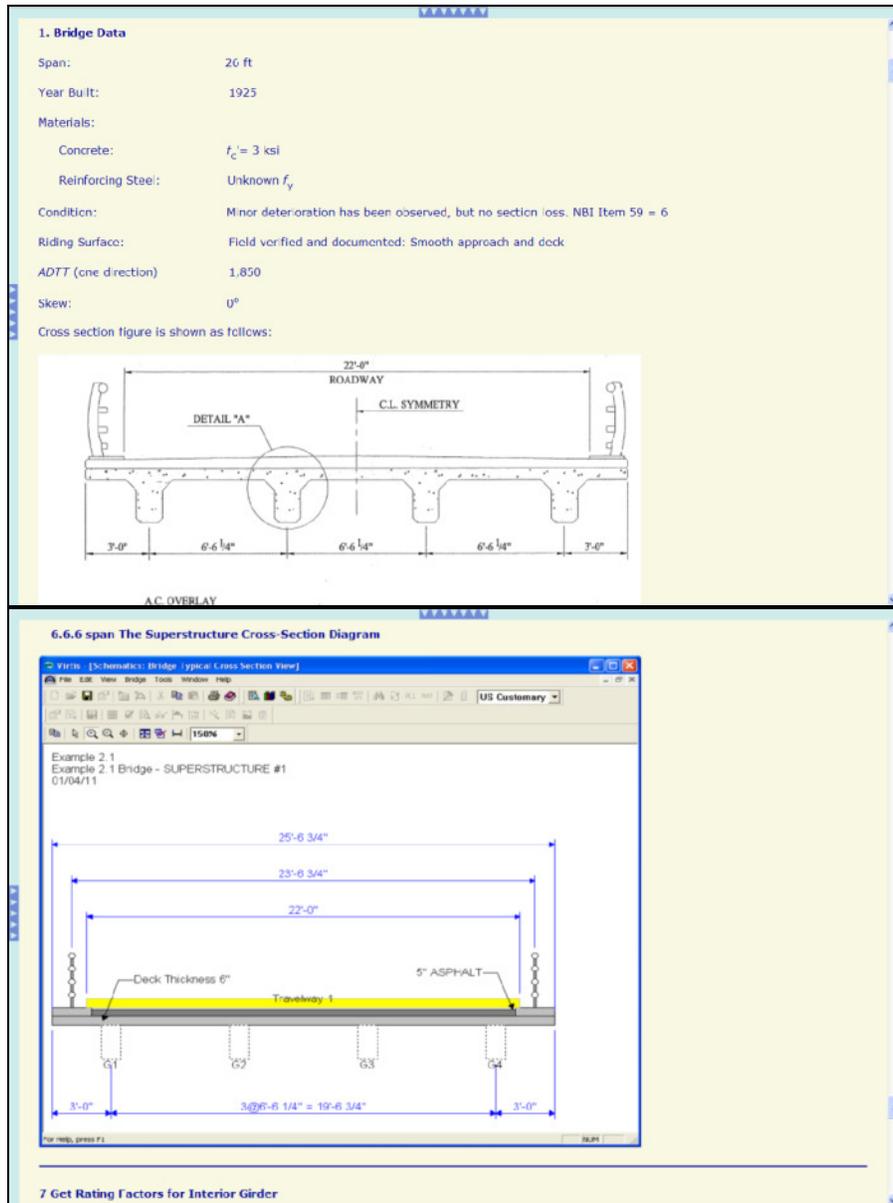


Figure 3-26. Partial pages for the Virtis™ reinforced-concrete bridge-rating example

3.7.3.3 Virtis™ Rating Example for Prestressed-Concrete Bridge This section contains a rating example for a typical prestressed-concrete bridge using Virtis™ (see Figure 3-27).

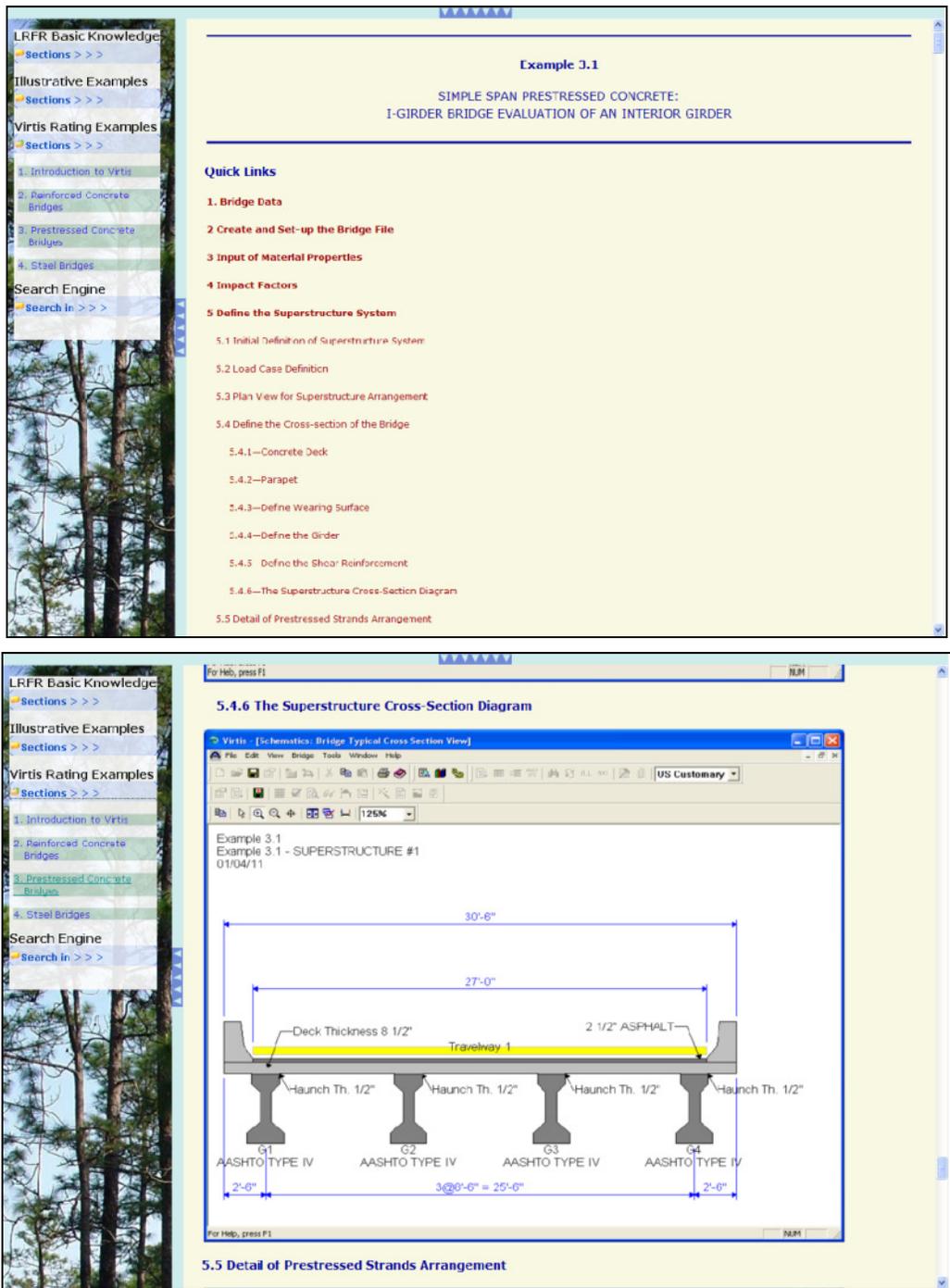


Figure 3-27. Partial pages for the Virtis™ prestressed-concrete bridge-rating example

3.7.3.4 Virtis™ Rating Example for a Steel Bridge This section presents a rating example for a typical steel-girder bridge using Virtis™ (see Figure 3-28). Key pictures show the step-by-step process in Virtis™. The users of this section may get a general understanding of the rating procedure for steel bridges using Virtis™.

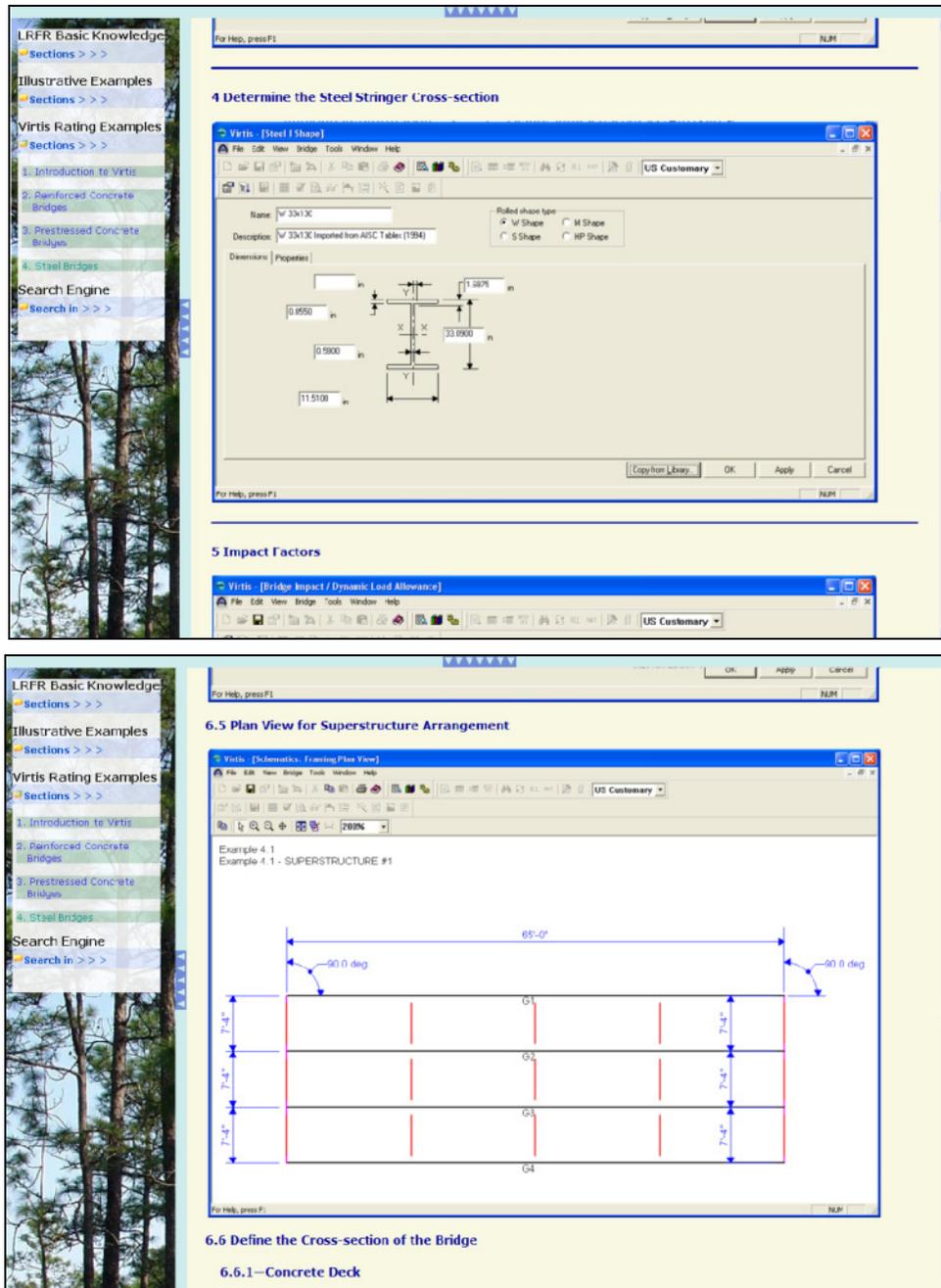


Figure 3-28. Partial pages for Virtis™ rating example for a steel bridge

3.8 Search Options

A search engine is included for conveniently looking up definitions related to bridge design and bridge rating and for locating keywords in the package. Figures 3-29 and 3-30 show examples of a keyword search in the dictionary and in the package respectively.

3.8.1 Search

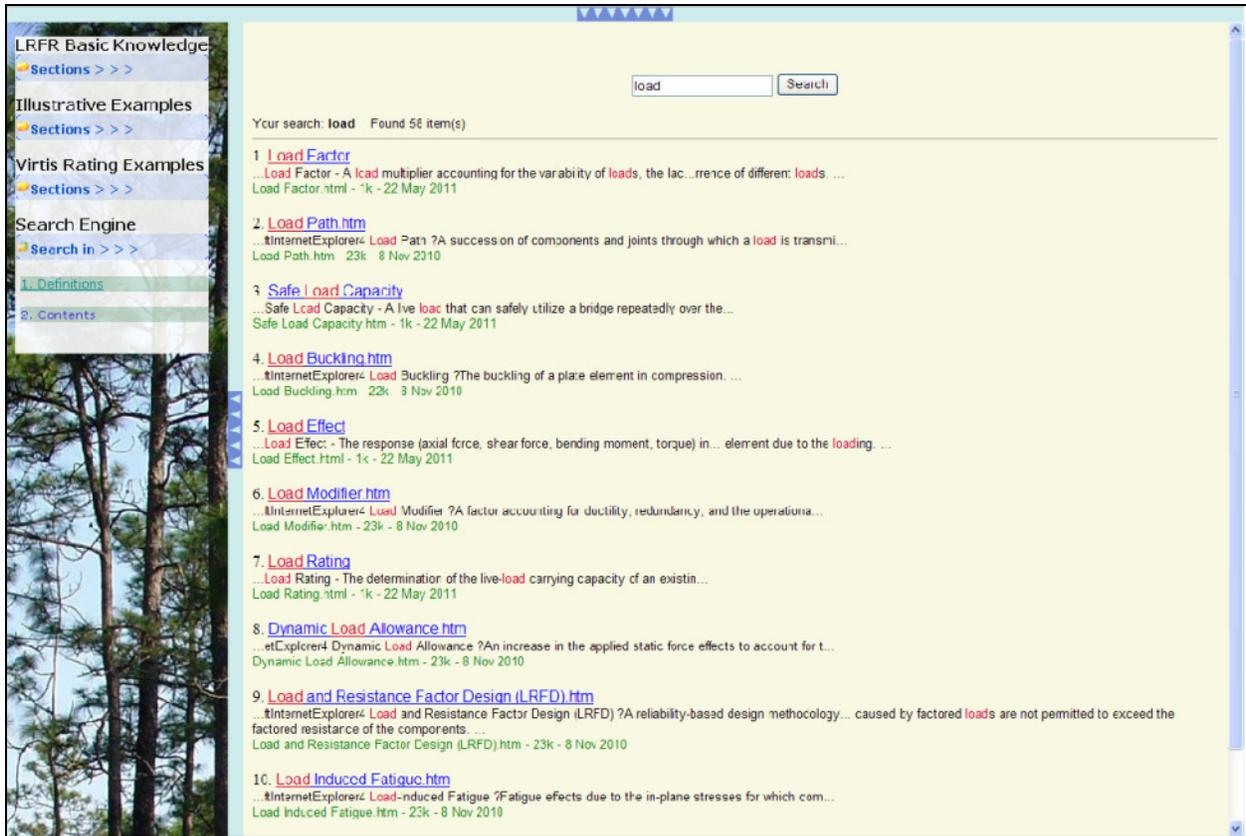


Figure 3-29. Page showing results for a keyword search in the dictionary

3.8.2 Package Search



The screenshot displays a web-based search interface for a software package. On the left, there is a navigation menu with sections: "LRFR Basic Knowledge", "Illustrative Examples", "Virtis Rating Examples", and "Search Engine". The "Search Engine" section is active, showing a search bar with the text "loading" and a "Search!" button. Below the search bar, the results are listed as follows:

Your search: **loading** Found 21 item(s)

- 1. LOAD AND RESISTANCE FACTOR RATING PART A**
...ges in condition or **loading** noted during the inspection. 6A.1.2 Scope Part A provides procedures for...for the LRFD design **loading**, AASHTO and State legal loads, and overweight permit loads. These proced...
Load Rating/PART A.html - 113k - 12 Aug 2010
- 2. INTRODUCTION AND GENERAL INFORMATION ABOUT RATING**
... safety. The actual **loadings** are combined to produce a maximum stress in a member, which is not to e...cations using HL 93 **loading**, prior to October 1 st , 2010, temo 63, 64, 65 and 66 [1] are to be com...
Rating General/Main Frame.html - 48k - 7 Dec 2010
- 3. INSPECTION**
...12.3 Inspection for **Loadings** 4.12.4 Inspection for Resistance APPENJIX A4.1 STRUCTURE INVENTORY AND ...streambed load, ice **loading**, navigation traffic collision, and deleterious effects of water movement...
Inspection/Main Frame.html - 287k - 27 Jul 2010
- 4. ALLOWABLE STRESS RATING AND LOAD FACTOR RATING**
...essed Concrete 6B.7 **LOADINGS** 6B.7.1 Dead Load: D 5B.7.2 Rating Live Load 6B.7.2.1 Wheel Loads (Decks...s 6B.7.2.4 Sidewalk **Loadings** 6B.7.2.5 Live Load Effects: L 6B.7.3 Distribution of Loads 6B.7.4 Impac...
Load Rating/PART B.html - 62k - 4 Aug 2010
- 5. NONDESTRUCTIVE LOAD TESTING**
d and predatamined **loadings** without causing changes in the elastic response of the structure. Load members' response to **loading**, or both cannot be determined because of lack of existing as-built infor...
Nondestructive Load Testing/Main Frame.html - 98k - 13 Dec 2010
- 6. General**
...cations using HL-93 **loading**, prior to October 1 st , 2010, Items 63, 64, 65 and 66 [1] are to be com...methods using HL-93 **loading** or LFR methods using MS18 **loading**. Metric ton rating values shall be rep...
General/Main Frame.html - 3k - 23 Jul 2010
- 7. Example 3.1 SIMPLE SPAN PRESTRESSED CONCRETE I-GIRDER BRIDGE EVALUATION OF AN INTERIOR GIRDER (LRFR ONLY)**
...on (HL-93 Inventory **Loading**): V LL+IM = 65.3 kips V DC ?= 74.5 kips V DW ?= 7.03 kips Load Load ... bearing) for HL-93 **loading** Calculated by statics with the loads applied no closer than 5.37 ft from...
PC Bridge Examples/Example3.1/Main Frame.html - 239k - 22 May 2011
- 8. BRIDGE FILES**
...ign Load . The live **loading** for which the bridge was designed should be stated if it is known. A str...s to have each live **loading** specified. If the design live **loading** is not known, this should be so in...
Bridge Files/Main Frame.html - 61k - 14 Dec 2010
- 9. EXAMPLE 4.2 FOUR-SPAN CONTINUOUS STRAIGHT WELDED PLATE GIRDER BRIDGE: EVALUATION OF AN INTERIOR GIRDER**
Load and Permit **Loadings** (shows lane type **loading**) 5.2.4 Calculate Maximum Negative Moment at D... and the Lane Type **Loadings** is covered for the specific

Figure 3-30. Page showing results for a keyword search in the software package

3.9 Contact Page

This page provides contact information for the PI (see Figure 3-31).

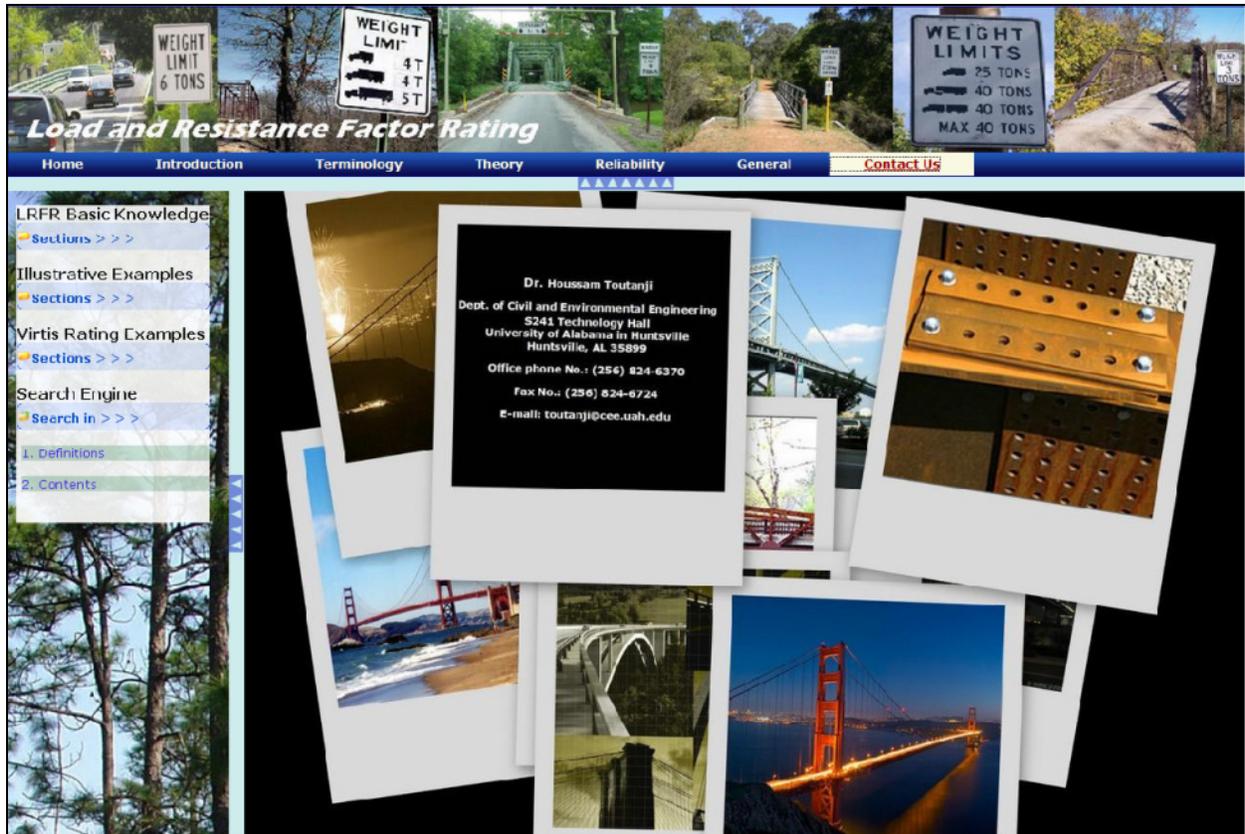


Figure 3-31. Page showing Dr. Toutanji's contact information

3.10 Conclusion

The purpose of this project was to create a user-friendly, aesthetically pleasing software package that teaches VirtisTM software and rating methods and procedures. Users can use the software to get acquainted with LRFR rating procedures and operations. This multimedia package can be updated at any time to reflect today's technology and theory.

Multimedia technology provides many advantages: step-by-step details are presented using diagrams, equations, examples, tables, definitions, and theories. This multimedia package can be used like a reference tool for people trying to learn the specifications, methods, and procedures of bridge evaluation and bridge load rating. Another advantage is that the information can be modified whenever desired, including changing requisites and including more examples.

This complete package is available in the Department of Civil and Environmental Engineering at the University of Alabama in Huntsville.

Section 4

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