Multimedia Technology for Bridge Repair: Final Phase

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15. Supplementary Notes

A CD-ROM and a web site (http://coeweb.eb.uah.edu/cee/ALDOT/login.htm) were developed. To access the web site both a username and a password are required.

16. Abstract

This project focused on providing guidelines for conducting concrete and timber bridge inspections for the Alabama Department of Transportation (ALDOT), and evaluating and understanding the various maintenance procedures available for this purpose. A self-training tool was developed in the form of a multimedia website and a CD-ROM. This website is intended to provide the inspector with an understanding of the general characteristics of deterioration and the concepts related to inspection procedures. This tool can be very valuable to ALDOT and county engineers because it describes procedures for inspecting bridges, and it has step-by-step instructions, accompanied by photographic illustrations for the various maintenance procedures utilized by ALDOT.

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Repair, rehabilitation, strengthening, retrofit, bridge inspection, replacement, bridges, multimedia, concrete bridge, timber bridge	

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Executive Summary

The advent of multimedia technology provides an excellent opportunity for the development of tools to train engineers on the various practices used by the Alabama Department of Transportation (ALDOT) for assessing and repairing structures. Multimedia training tools can also provide easy access to the guidelines for evaluating structural damage, and step-by-step instructions for the remedial processes that are used by ALDOT. Multimedia technology is advantageous because it can be easily modified to accommodate future changes in inspection and repair procedures exercised by ALDOT.

Bridge inspectors have the difficult task of accurately assessing the condition of an existing structure. While concrete bridge inspection requires extensive knowledge of concrete behavior and careful examination of structural components, timber bridge inspectors must understand the biotic and physical factors associated with wood deterioration as well as the relative rate at which these processes occur in a given environment. ALDOT bridge workers must also be familiar with specially coded bridge inspection and maintenance forms such as the Bridge Inspection Condition Report (BI-5) form and the Bridge Maintenance Needed (BI-9) form. Such forms are used to appropriately evaluate bridge conditions and to request necessary remedial work.

This project focused on providing guidelines for conducting concrete and timber bridge inspections for ALDOT, and evaluating and understanding the various maintenance procedures available for this purpose. A self-training tool was developed in the form of a multimedia CD-ROM/web site, intended to provide inspectors with an understanding of the general characteristics of deterioration and the concepts related to inspection procedures. This tool can be very valuable to ALDOT and county engineers because it describes procedures for inspecting existing bridges. It also has step-by-step instructions, accompanied by photographic illustrations, for the various maintenance procedures utilized by ALDOT.

The developed website will be maintained in the Civil and Environmental Engineering Department at The University of Alabama in Huntsville, where it will be periodically updated by the Principal Investigator.

1.0 Introduction

The objective of this research project was to create a multimedia product to assist the Alabama Department of Transportation (ALDOT) in evaluating the damage to timber bridges and estimating costs associated with remedial procedures. This self guided tool will cover the fundamentals of bridge inspection for decay and deterioration.

The age distribution of national bridges indicates increasing deterioration of structures constructed in the 1930s and earlier, and a parallel need for improvement of bridges built during the Interstate period. According to Xanthakos (1996), of the nation's 577,000 bridges about 40 percent are structurally deficient or functionally obsolete. A deficiency occurs when a performance element is at or below a specified minimum level, generally established from a consensus of technical expertise within the engineering discipline. Deficiencies in the bridge system are categorized as a variety of physical and operating problems such as high level of congestion or riding discomfort, inadequate load capacity, compromised safety or other related conditions.

Damage to concrete bridges may be caused by collision impact or by defects brought about by gradual aging of the structure. Concrete tends to crack and lose strength after being exposed to the environment for a long period of time. Reinforcing steel is also subject to corrosion when exposed to the elements. Wood used for timber bridges is subject to deterioration by a variety of agents (Ritter 1992). Damage ranges from relatively minor discolorations caused by fungi or chemicals to more serious decay and insect attack.

Maintenance operations can be undertaken to correct situations that could otherwise lead to the difficult task of accurately assessing the condition of an existing structure. Inspectors must understand the characteristics of bridge materials and the causes associated with their deterioration, as well as the relative rate at which it occurs in a given environment.

The advent of multimedia technology provides an excellent opportunity to train engineers in the design, inspection and repair practices used in civil engineering. In addition to the accessibility of this self-guided tool, multimedia technology is easily adaptable and extensible to future changes.

2.0 Methodology

The groundwork for this project started with a literature review, which helped the Principal Investigator understand the different techniques available for the assessment of bridges. To make the process of bridge evaluation and repair manageable the project was divided into two main parts: concrete and timber. ALDOT engineers recommended that the focus be on creating a multimedia tool that would help maintenance employees interpret the various methods and tools required for inspection and maintenance of bridges.

The concrete section provides engineers with tools that outline step-by-step details for concrete bridge maintenance and structural repair, while the timber section provides such details for maintaining and repairing timber bridges. ALDOT personnel also suggested making field visits with ALDOT maintenance employees as repairs were being made. During this process, a project assistant took pictures of several timber bridges in Alabama for illustrative purposes.

The Principal Investigator of the project met with managers of the ALDOT Maintenance Bureau on a regular basis. Bridge maintenance personnel frequently reviewed and commented on the materials as they were developed during this project. Their comments and recommendations were addressed and incorporated in the final multimedia resource package.

3.0 Website/CD-ROM Description

The multimedia resource includes a main homepage which presents the two main sections of the module, Concrete and Timber. The following is a description of these sections and their respective links.

3.1 Main Homepage

The main homepage presents the main concrete and timber sections with links to the various parts of each section (see Figure 3-1).

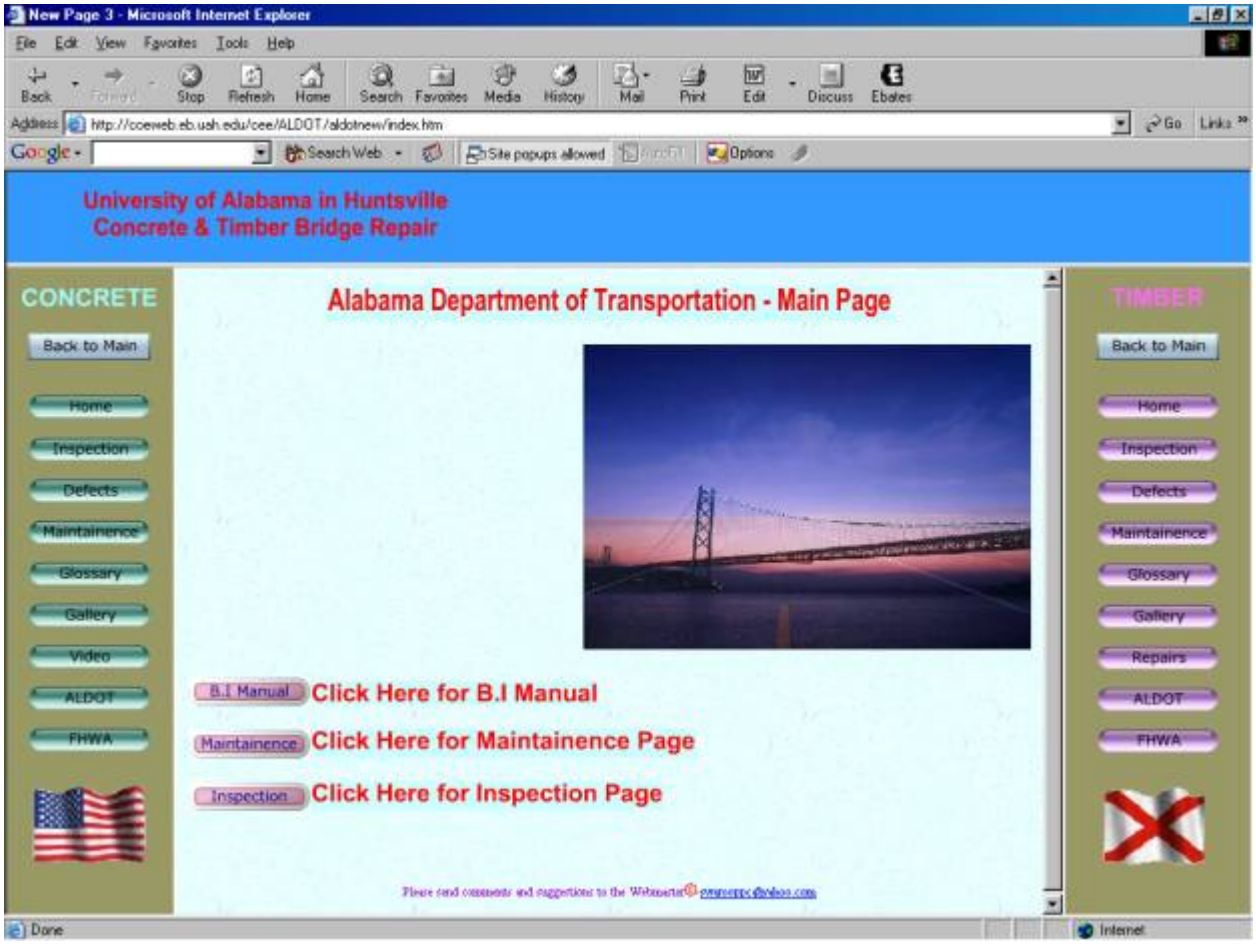

Figure 3-1. Home page of the ALDOT concrete and timber bridge repair website

3.2 Concrete

Home

This link takes the user to the concrete bridge homepage, which includes a welcome greeting and a brief description of the purpose of the web site. A web search tool is also provided on the left side of the page (see Figure 3-2).

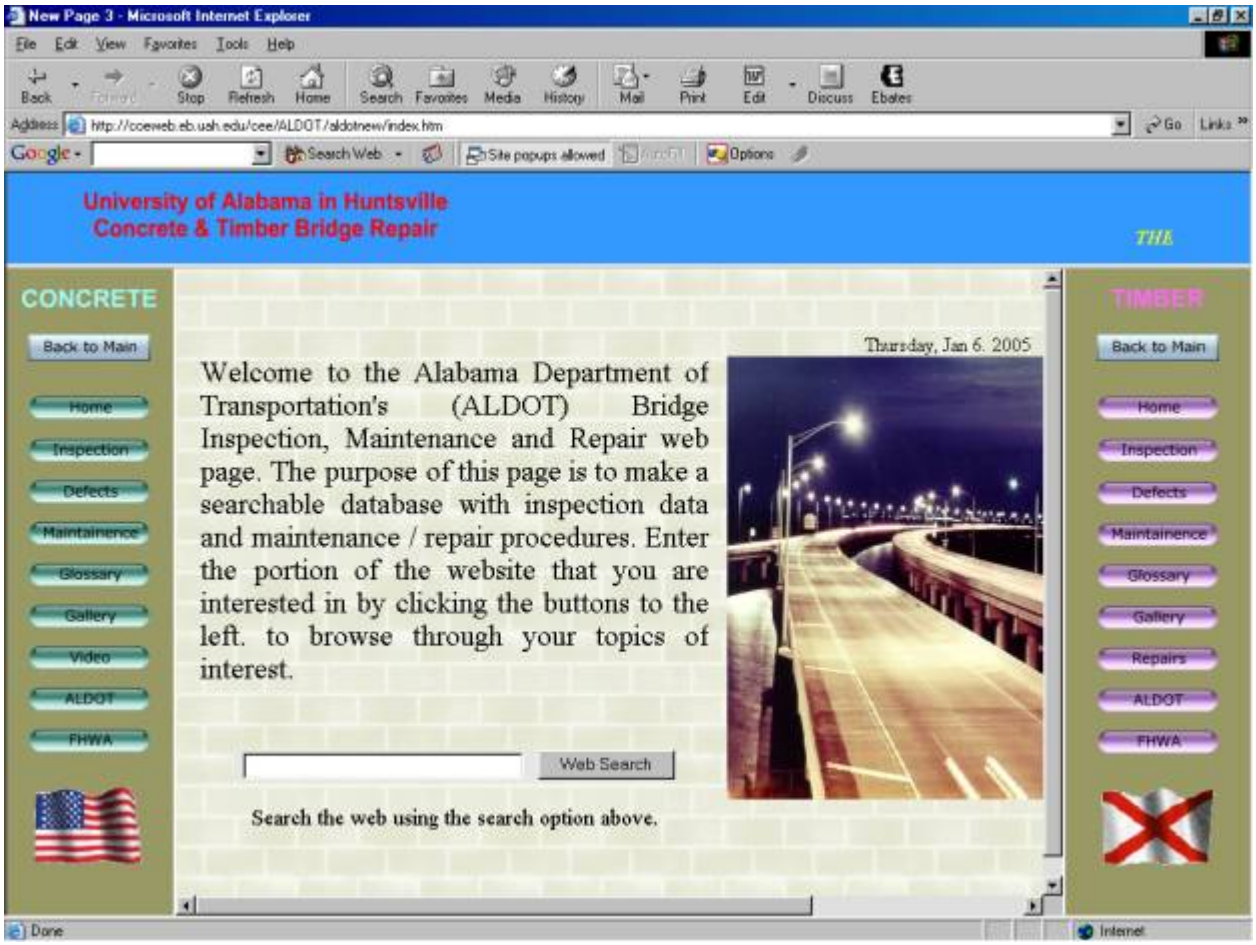

Figure 3-2. Concrete home page of the ALDOT concrete and timber bridge repair website

Inspection

The inspection link takes users to the guidelines for conducting concrete bridge inspections. ALDOT bridge inspectors use the Bridge Inspection Condition Report (BI-5) for evaluating and recording the condition of bridges. The website provides step-by-step instructions, explaining exactly what the inspector should look for and how to assign the appropriate condition rating. This report is coded and special knowledge of the coding is required.

The inspection page contains a series of drop menus containing items 1 through 293 of the BI-5 form (see Figure 3-3). When a particular item is selected from the drop menu, a description of that item is displayed, along with instructions for entering the coded rating. Only items 58 through 62 are associated with concrete bridge inspections.

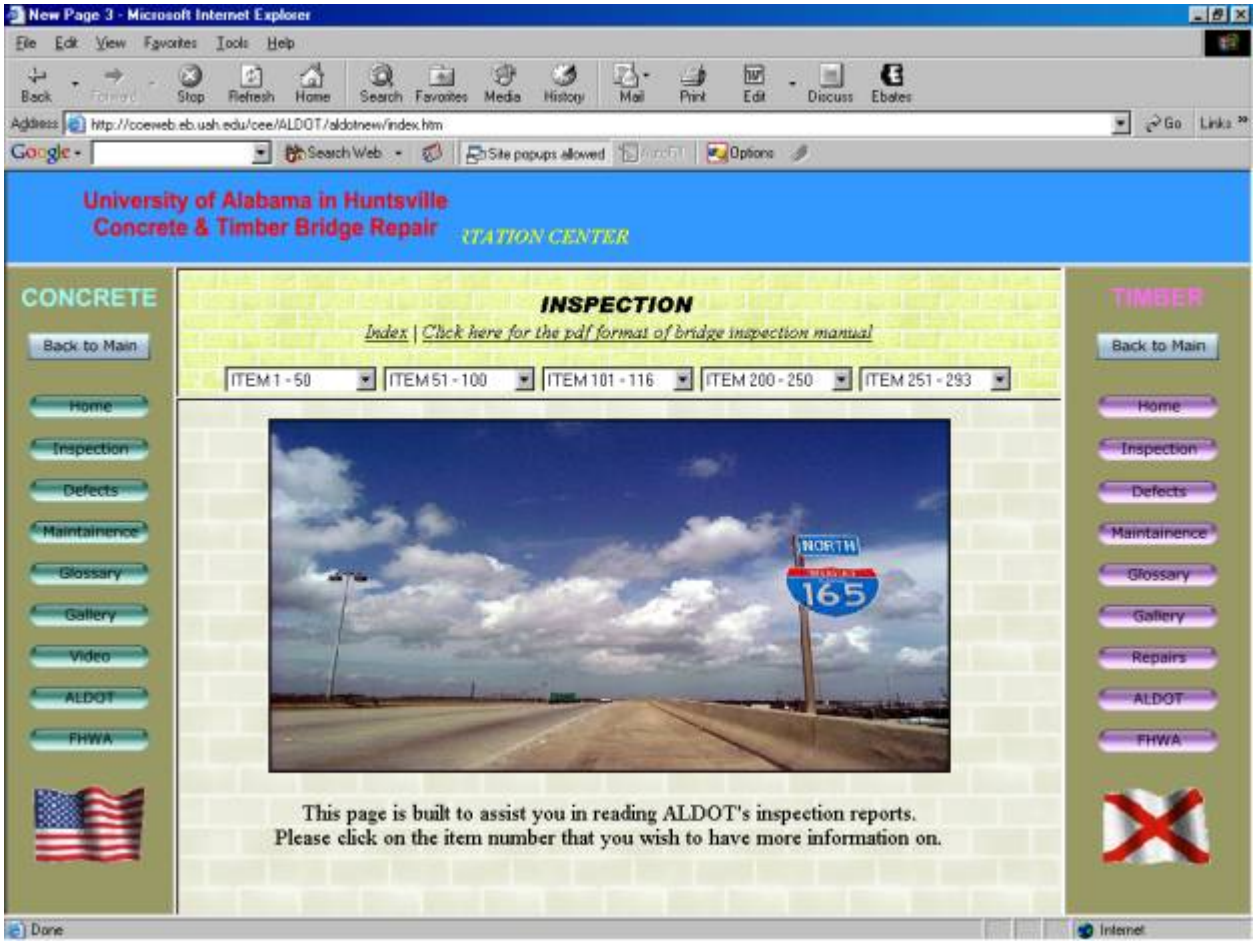

Figure 3-3. Inspection page of the concrete bridge section

When an item is selected from the inspection page, a description of that item is displayed followed by instructions for rating its subitems. Guidelines such as "*What to Rate*", "*Typical Types*" and "*What to Look For*" are also included.

For demonstrational purposes, the following information is a reproduction of the information provided when Item 58 is selected from the inspection page. The illustration begins on the following paragraph and ends on page 14.

***********Begin Bridge Inspection Manual Information for Item 58*********

Item Code: 58
Topics: DECK
Digits: 1 DIGITS
Description: This item describes the overall condition rating of the deck. If the structure is a bridge, each component of the deck is rated using the BI-5 form before an overall condition rating for the deck can be determined. Each subitem is coded and then an overall condition rating is determined for the deck. The overall condition rating will also be displayed on screen 10 of the BI-6 form. If the structure is a culvert, a code of "N" will be displayed in the BI-6 module.
In finding the overall condition rating of the deck, the condition of the wearing surface, joints, expansion devices, curbs, sidewalks, parapets, fascias, bridge rails, and drainage devices are not considered. The overall condition of the deck is to only consider the structural integrity of the deck and its capability to carry traffic. However, each of these components is rated on the BI-5 using 1-digit condition codes. Also, pertinent remarks about the specific findings are written on the BI-5 at the bottom of each item in the Remarks field. If a particular subitem, such as paint, is not present on the deck, then the subitem is coded "N" for "Not applicable".

Code	Description
N	Not applicable
9	Excellent Condition
8	Very good condition - no problems noted
7	Good condition - some minor problems
6	Satisfactory condition - structural elements show some minor deterioration.
5	Fair condition - all primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
4	Poor condition - advanced condition loss, deterioration spalling or scour.

3 Serious condition - loss of section, deterioration, spalling or scour may have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.

2 Critical condition - advanced deterioration of primary structural Elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the structure until corrective action is taken.

1 Imminent failure condition - major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Structure is closed to traffic but corrective action may put it back in light service.

0 Failed condition - out of service: beyond corrective action

All the subitems listed under Item 58-Deck are described below.

Subitem 58.1--WEARING SURFACE

Use a 1-digit code to describe the overall condition rating of the deck-wearing surface.

What to Rate: The physical condition and riding quality of the wearing surface are examined and rated. When the wearing surface is monolithic with the structural deck, only the surface that vehicles bear on is rated. When the wearing course is separate from the structural deck, the full thickness of the wearing course(s) is considered.

Typical Types: Typical types of wearing surfaces include the following:

1. Asphalt overlays
2. Portland cement concrete overlays
3. Portland cement concrete decks with monolithic wearing surface
4. Steel grating (open of filled)
5. Timber

What to Look For: The type of wearing surface being rated will determine what to look for. A summary of typical factors includes the following:

1. Asphalt overlays: Look for cracking, raveling, potholing, shoving, rutting, and drying out.
2. Concrete overlays: Look for scaling, spalling, cracking, rutting and exposed reinforcing.
3. Monolithic deck: Check for scaling, spalling, cracking and rutting.
4. Steel gratings: Inspect for broken wells and rivets. Observe for rattling, vibration or deflection with the passage of traffic. Check the alignment and profile of the grating.

5. Timber: Rough surfaces due to wear are a frequent problem with timber wearing surfaces. Also, observe if the wearing surface is properly fastened and not rotting. Look for signs of insect attack or fire damage.

Subitem 58.2--DECK-STRUCTURAL CONDITION

What to Rate: In rating the structural condition of the bridge deck, integral or separate wearing courses are not included in the deck ratings. Also, deck slabs that can span between substructure supports (i.e., do not have a separate flooring system) are rated as primary members, not as part of the deck.

Typical Types: Listed below are typical types of bridge decks.

1. Concrete with separate wearing courses
2. Concrete with integral wearing courses
3. Concrete with or without stay-in-place forms
4. Open and filled steel grating
5. Metal orthotropic
6. Timber

What to Look For: On concrete deck slabs, check for scaling, spalling, cracking, efflorescence, dampness, potholing, delamination, chloride contamination, full or partial depth failures and leakage. Frequently leakage appears on steel supporting members indicating that deck deterioration is taking place. Look very closely at the underside of the deck along curb lines, near joints, and at other low areas of the deck where deterioration normally starts. When rating concrete deck slabs, remember that concrete deterioration normally starts at the top of the deck and along its periphery. From these locations the deterioration progresses downward and inward until the entire slab is involved. Therefore, when minor deterioration is observed on the bottom of a slab, there is a good chance that the deterioration is much worse above this point and the slab is rated accordingly. For concrete decks with stay-in-place forms, inspect the forms and supporting beams for rust and other signs of leakage coming through the deck. With open steel grating decks, look for broken welds and rivets. Check alignment and profile of open and filled grating decks. Look to see that gratings are properly bearing on supporting members. Check the grating for cracks and listen for the sound of loose grating as traffic crosses the bridge. On orthotropic decks, check for leakage, corrosion, loss of section, and proper support. Timber decks are observed for looseness, dampness, decay, splitting, crushing, fastener failure and wear. Especially close attention is given to locations where timber decking rests on other members. These areas hold water and are frequently damp and especially vulnerable to decay. Observe all decks with the passage of live loads. Look for excess deflection and listen for any unusual sounds with the passage of live loads.

Subitem 58.3--CURBS

Use a 1-digit code to describe the overall condition of the curbs.

What to Rate: Rate the physical condition of the curb and its ability to function as originally designed.

Typical types: Listed below are typical types of material of which curbs are frequently constructed:
1. Granite
2. Steel
3. Concrete
4. Timber

What to Look For: A summary of what to look for in evaluating the overall condition of a curb follows below:

1. General: Always check for impact damage and proper alignment. Be alert to the fact that overlaying bridge decks will lower curb heights and reduce the effectiveness of the curb, as originally designed. The curb is not rated based on its ability to meet present- day design standards.
2. Granite: Look for broken or loose sections.
3. Steel: Check for proper anchorage.
4. Concrete: Looking for spalling, scaling and other forms of concrete deterioration. Check for exposed reinforcing and proper alignment.

Subitem 58.4--MEDIAN

Use a 1-digit code to describe the overall condition rating of the median.

What to Rate: Rate the condition of the median including curbs, concrete backing, stone chips, guide railing and median barrier.

Typical Types: Listed below are some typical types of median:

1. Raised medians with or without median railing
2. Concrete median barriers
3. Open steel grating
4. Flush medians with stone chips
5. Steel median barriers
6. Guide railing

What to Look For: Inspect median, curbs, concrete backing, stone chips, guide railing, and media barrier when they exist. The lowest rated of these is coded under this subitem Flush medians are

not rated under this subitem, unless they have open steel grating, median barrier, guide railing, or a stone chips surface. For these four exceptions, the lowest rated of the four elements present is coded on the form. Inspect the appropriate elements for deterioration, signs of physical distress, proper alignment, and proper supports.

Subitem 58.5--SIDEWALKS

Use a 1-digit code to describe the overall condition rating of the sidewalks.

What to Rate: Consider the condition of both the sidewalk and the deck fascia in rating this subitem. However, only the lowest rated of the two elements is coded on the inspection form.Sidewalks and fascias are usually constructed of the following materials:

1. Concrete
2. Timber
3. Metal
4. Masonry

What to Look For: All sidewalks are inspected for their walking surface quality. Sidewalks that behave as a structural element and not merely as an overlay, are inspected for their structural ability to span between supports. When inspecting fascias, look for the normal signs of material deterioration. Be aware that one common Function of a fascia is to support railing anchorages. If serious deterioration has occurred and it is no longer capable of supporting railing anchorages as originally intended, it is rated no higher than 3. Fascias can also cause problems if pieces of concrete fall on pedestrians or vehicular traffic under the bridge.

Subitem 58.6--RAILING

Use a 1-digit code to describe the overall condition of the railing.

What to Rate: Railings and parapets are inspected and rated for physical condition and for their ability to function as originally designed. A railing is not rated based on its ability to meet current design standards. When both railings and parapets occur on the same span, the lowest rated of the two elements is coded.

Typical Types: Bridge railings and parapets are usually constructed of the following types of material:

1. Steel
2. Aluminum
3. Concrete
4. Timber
5. Masonry

What to Look For: The elements are examined for deterioration and impact damage. Metal elements are inspected for cracks and section loss due to corrosion. Special attention is given to fasteners and anchorages. On concrete members, look for spalls cracks, and efflorescence. Timber components are inspected for splitting, rot insect attack and proper connection to supporting members. Do not consider railing paint in rating this subitem. Railing paint or galvanizing is rated under the "Paint" subitem as explained in the next paragraph.

Subitem 58.7--PAINT

Use a 1-digit code to describe the overall condition of the railing paint.

What to Rate: Rate the condition of the protective system on metal bridge railing, lighting standards, or any other component of the deck which may be galvanized or painted.

What to Look For: Look for cracking, chipping, scaling, rust pimples, and excessive chalking. If the paint film has disintegrated, note whether the prime coat or the metal surface is exposed.

Subitem 58.8--DRAINS

Use a 1-digit code to describe the overall condition of the deck drainage.

What to Rate: Rate the ability of the approach drainage system to prevent water from running into the bridge and of the deck for its ability to remove water from the bridge and approach roadway.

What to Look For: Normally the approaches are drained by crowding the roadway and sloping the shoulders to side ditches, gutters or catch basins. Check for pavements that are no longer crowded, have high shoulders, or have low spots, eroded ditches or gutters, gutters filled with debris, and clogged catch basins. Check for water ponding on the approaches creating the possibility of hydroplaning. Check the high end of bridges on continuous grades for water running onto the bridge. Inspect the physical condition of the elements comprising the drainage system, such as scupper grates, downspouts, piping, downspout hoppers, etc. Be sure that the system is not plugged with debris and that water is being diverted so that it does not promote deterioration of a bridge element.

Rating: The numerical code indicates the condition and effectiveness of the approach drainage system. A rating of "8" would indicate an effective system in nearly new condition. Gutters filled with mud or debris or other minor deficiencies which do not cause a serious problem with the drainage from the approach roadway would be rated "5" or "6". Erosion of gutters would be rated "5" to "3" depending on severity. Any condition which causes ponding on the approach roadway or allows water to run onto the structure is rate "1" or "2".

Subitem 58.9--LIGHTING STANDARDS

Use a 1-digit code to describe the overall rating of the lighting standards.

What to Rate:. Rate the lighting standards and supports on a per span basis. Rate any type of lighting, i.e., roadway lighting, sign lights, traffic control, navigational lights, or aerial obstruction lights.

What to Look For: On concrete supports, look for cracks and spalls. On steel supports, check for rust, corrosion and cracks. On aluminum supports, check for fatigue crack particularly on roadway lights. On timber supports, check for rotting, insect attack, and splitting. Check all supports for loose connections, vandalism, and collision damage.

Subitem 58.10--UTILITIES

Use a 1-digit code to describe the overall condition of the utilities on the bridge. Typical utilities are gas, water, electricity, cable TV, telephone and sewage.

What to Rate: Rate the condition of the utilities on the structure on a per span basis. This includes the pipes, ducts, conduits, wires, junction boxes, expansion joints, valves, vents, and insulation. Supports and braces are also rated under this subitem. The condition of the paint, if any, is rated under the “Deck Paint” subitem.

What to Look For: Check pieces of ducts for leaks, breaks, cracks, rust and deteriorated coverings. If abutment settlement has occurred, check for breaks and expansion joint problems. Check for water and sewage leaking onto decks or members and causing a corrosion problem. Check that the utilities below the bridge are not reducing the vertical clearance of freeboard. Check vents and drains on encasements of pressure pipes. Check electrical wiring for loose wires and bad insulation. Check junction boxes for moisture, drainage, insulation, and that the cover is in place. Check for cracks in conduits in sidewalks if there are cracks in the sidewalks. Check overhead lines for hanging objects. Check the condition of the supports and hangers for pipes and conduits.

Subitem 58.11--JOINT LEAKAGE

Use a 1-digit code to describe the overall condition of the deck joints in regard to their ability to seal out water. If the deck joints were not designed to seal out water, then a rating of “N” is assigned to this subitem.

What to Rate: Rate the overall condition of sealed joints for their ability to seal out water and debris.

What to Look For: Look for debris in the joint. Discoloration of the underside of the deck in the vicinity of the joint is also an indication that the joint may be leaking.

Rating: Joints which are designed to seal out water, but do not, are downrated for their failure to function as designed. If the joint leakage is causing deterioration to the bearings, girders, pedestals, etc., then this subitem is further downrated.

Similarly, clogged joint troughs or plumbing systems result in a downrating depending upon the problem the clogging is causing. Any exposed part of the joint plumbing system is also rated under this subitem.

Subitem 58.12--EXPANSION JOINTS/DEVICES

Use a 1-digit code to describe the overall condition of the expansion joints.

What to Rate: Rate the condition of all transverse deck joints. Include the condition of the adjacent header concrete at the abutment and the smoothness of the transition to the deck in determining the rating. Baffles, troughs, plumbing, and joint support framing are included in the rating for this subitem. Also, the joint opening measurements entered for items 221, 223, and 224 are considered when rating this subitem.

Exceptions: Bridge types such as rigid frames and filled arches have no joint with the deck. Certain construction details also result in no joint with the deck.

Typical Types. Typical types of deck joints are listed below:

1. Steel finger joints
2. Sealed armor joints
3. Unsealed armor joints
4. Steel angle joints
5. Propriety sealed joints

What to Look For: Check that the size of opening is reasonable and that there are no horizontal and vertical displacements of the joint or its elements. Also, check for horizontal misalignment. Look for debris in the joint or the joint trough and for deterioration of the joint materials. When under the deck, check for deterioration of the joint supports, deterioration of the joint supports, deterioration or displacement of troughs and baffles.

Subitem 58.13--COLLISION DAMAGE

Use a I-digit code to describe the overall condition of the collision damage. If the deck has no collision damage, rate this item “N”.

What to Rate: Rate the overall effect that the condition damage has on the deck in functioning as designed.

What to Look For: Look for evidence of collision damage by trucks, cars, busses, derailed railroad cars, etc. Damage will be evident in the form of shattered timber, sagging or buckled steel members, or large longitudinal cracks. Give the location and extent of damage and determine if immediate repairs are necessary.

Overall Rating

This 1-digit rating describes the overall condition and functional ability of the bridge deck. In finding the overall condition of the bridge deck, the condition of the wearing surface, joints, expansion devices, curbs, sidewalks, parapets, fascias, bridge rails, and drainage devices are not considered. The overall condition of the deck is to only consider the structural integrity of the deck and its capacity to carry traffic. Once entered the overall rating will be transferred by the ABIMS computer to update the deck rating displayed in the BI-6 module (Structural Inventory and Appraisal).

***********End Bridge Inspection Manual Information for Item 58*********

Defects

The defects page provides information about the various defects commonly found in concrete bridges. It is important that bridge inspectors are familiar with common defects and their causes. This page contains detailed information about these defects and their causes. Photographic illustrations are also provided. Figure 3-4 illustrates how this information is presented on the web page.

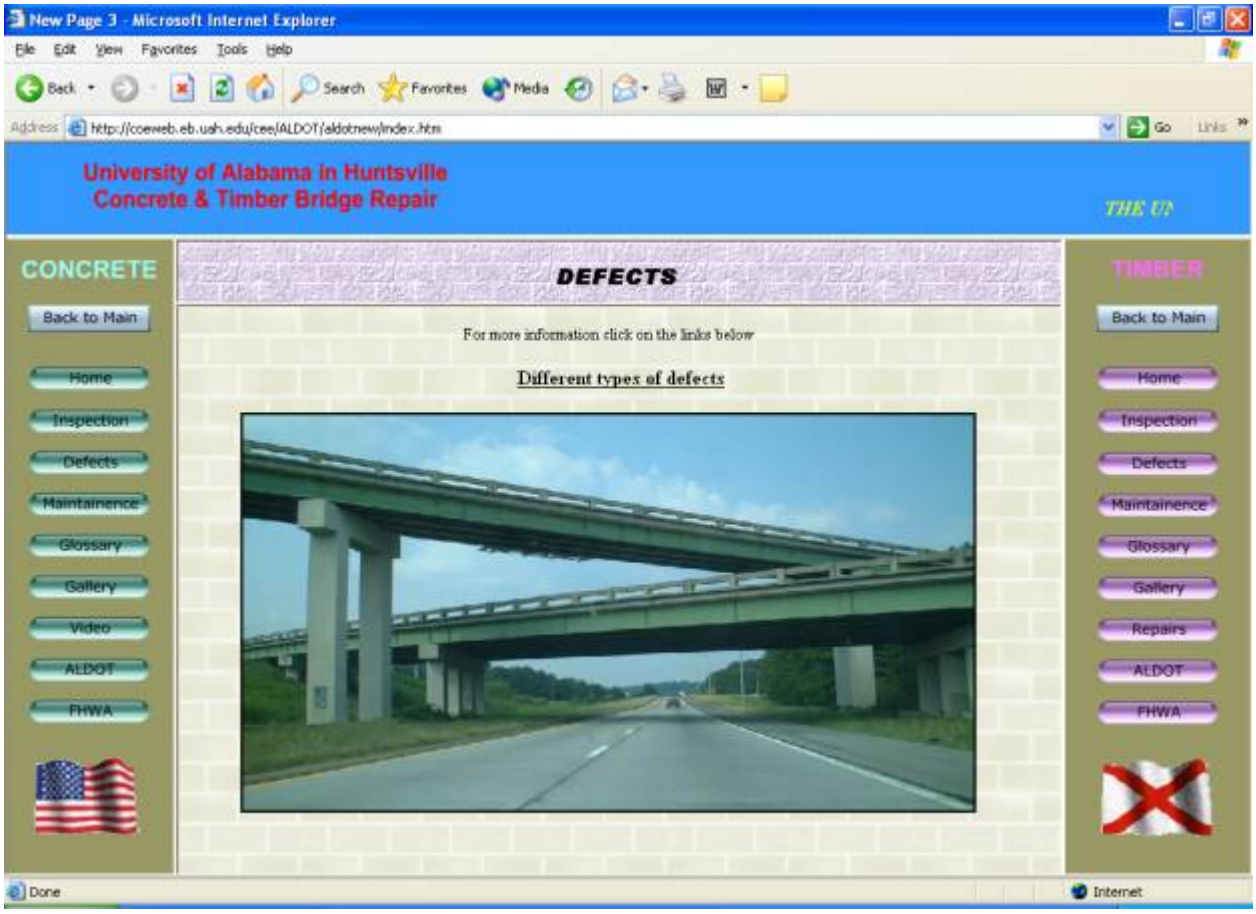

Figure 3-4. Defects web page illustration

Maintenance

The maintenance section describes the procedures practiced by ALDOT for maintaining and repairing concrete bridges. The Bridge Maintenance Needed Form (BI-9), Bridge Maintenance Performance Card (BI-10) and Secondary Road Bridge Maintenance Performance Card (BI-11) are coded forms used by ALDOT to help coordinate and record their maintenance activities.

Bridge inspectors use the BI-9 form to record the quantity of deficiencies found on a particular bridge. The BI-10 and BI-11 forms are used to record maintenance activities performed on state and local bridges respectively.

The website provides detailed information about specific bridge maintenance and repair procedures practiced by ALDOT. Step-by-step instructions for maintenance procedures are presented when items are selected from the drop menus (see Figure 3-5). Photographic illustrations are also provided for the individual steps.

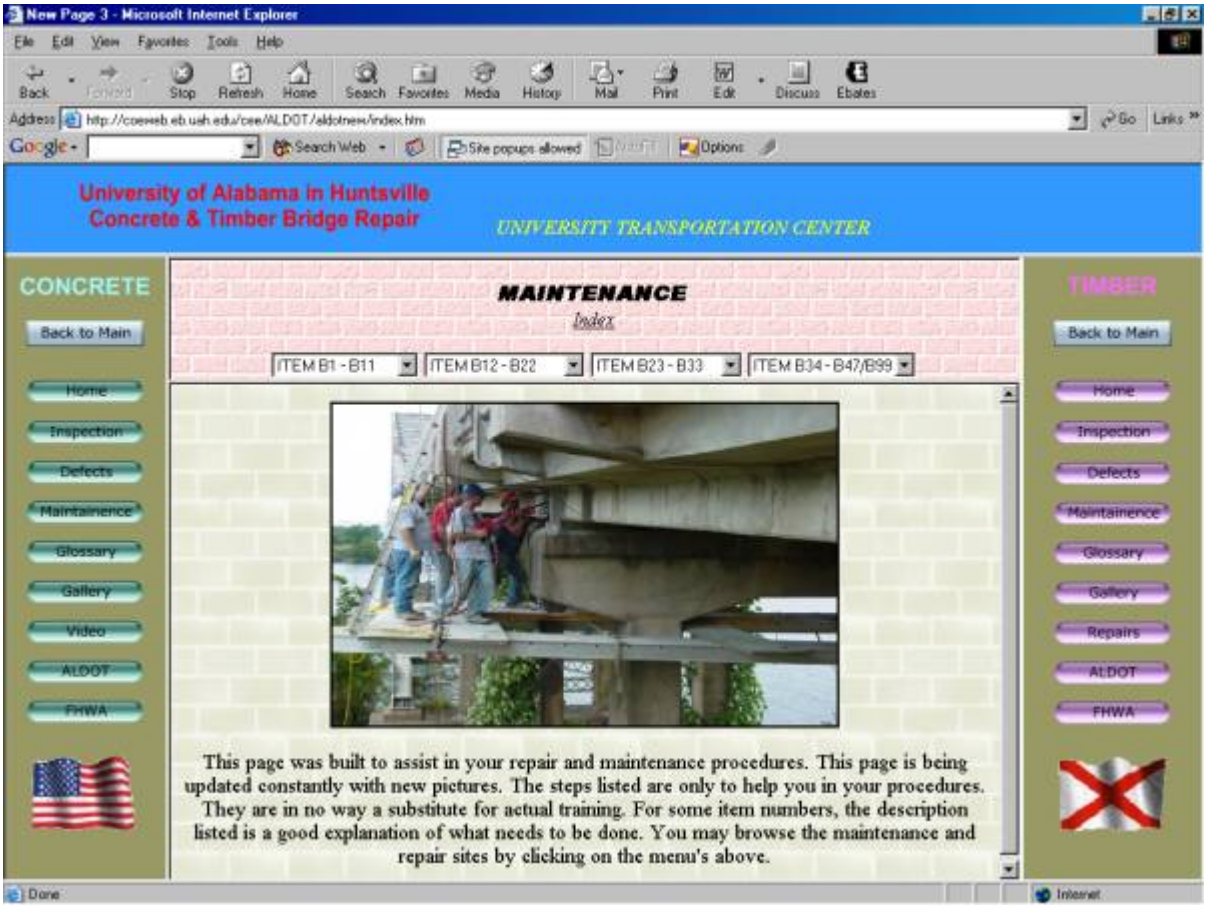

Figure 3-5. Maintenance home page for the concrete bridge section

For demonstrational purposes, the following information is a reproduction of the information provided when Item “B-9 is selected from the maintenance page. The illustration begins on the following paragraph and ends on page 18.

**********Begin Illustration of Item “B-9” from the Maintenance Page**********

ITEM #B-9

Major Deck Repair-Concrete

Description: *Major repair or replacement of a significant portion of the concrete deck. Includes*
Clean-up, capture, containment, and disposal of any residue
Placement or removal of overlay

The first step in doing a B-9 type repair is to create a safe and practical environment to work in. This is first done by setting up proper traffic control procedures.

This particular example was done on a bridge on AL 127. The inspectors noticed corrosion in the cap and the deck. There was significant calcium carbonate residue on both the deck and the cap that indicated corrosion.

After the cap was replaced (see B-18), the crews began removing the corroded deck materials. The small pothole seen in the picture ended up being a hole about 8 feet by 6 feet. This indicates that the concrete had been corroded under the asphalt. After the hole has been created, crews install a plywood cover on the bottom of the deck. The form is held in place by steel rods.

Once this form is in place the concrete is poured from above. The concrete is allowed to set for about 6 hours.

And then heavy steel plates are bolted to the old deck to provide support to traffic. About 48 hours after the concrete was poured, asphalt can be applied to the new deck, and traffic can resume.

**********End *Illustration of Item "B-9" from the Maintenance Page***********

Glossary

This page contains a list of key words that are relevant to the project along with their definitions (see Figure 3-6).

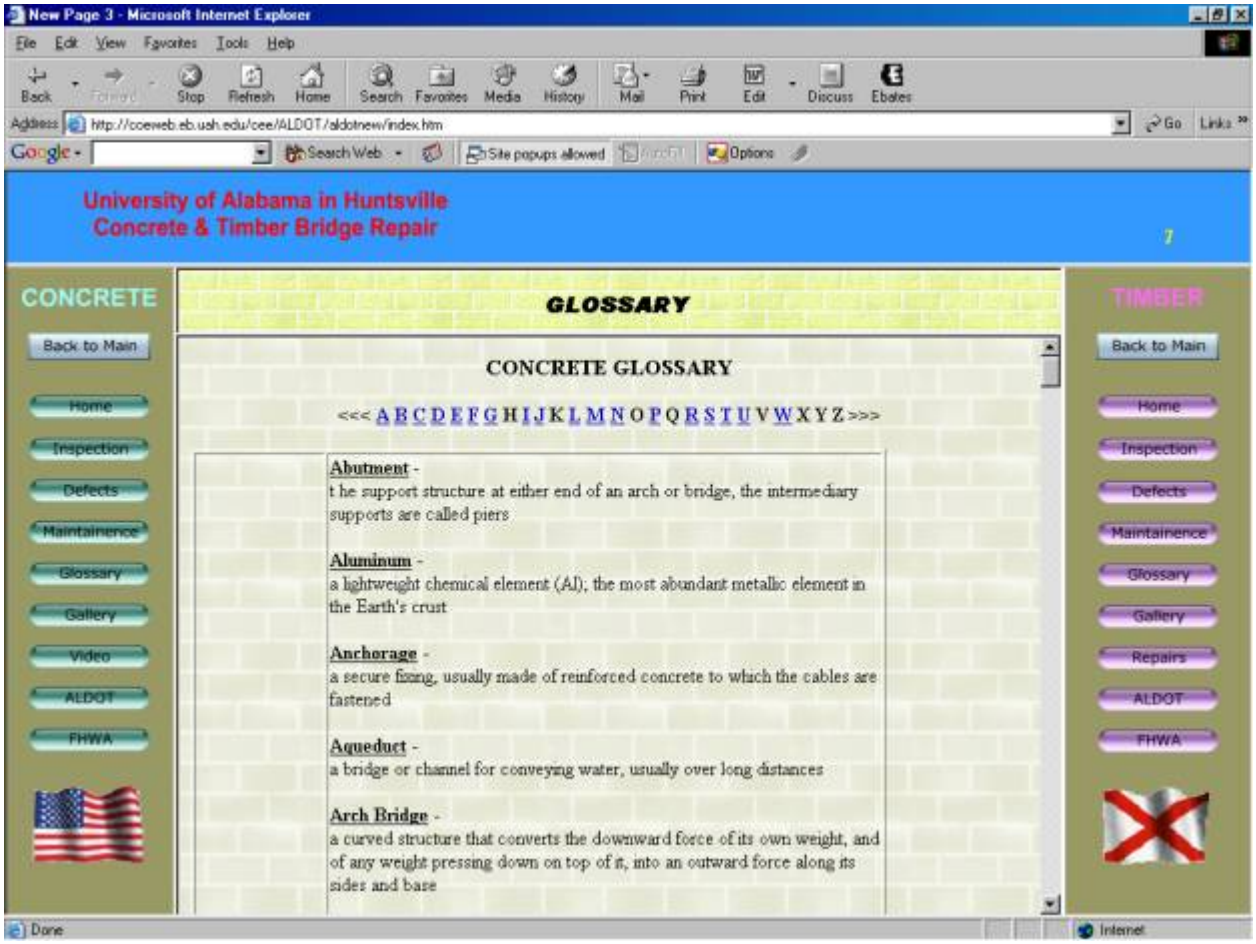

Figure 3-6. Concrete bridge glossary page containing words cited and their definitions

Gallery

The Gallery contains photos taken while several maintenance and inspection procedures were being conducted. This section also includes photos of a number of existing concrete bridges in Alabama (see Figure 3-7). Figure 3-8 shows a typical photo that can be found in this section.

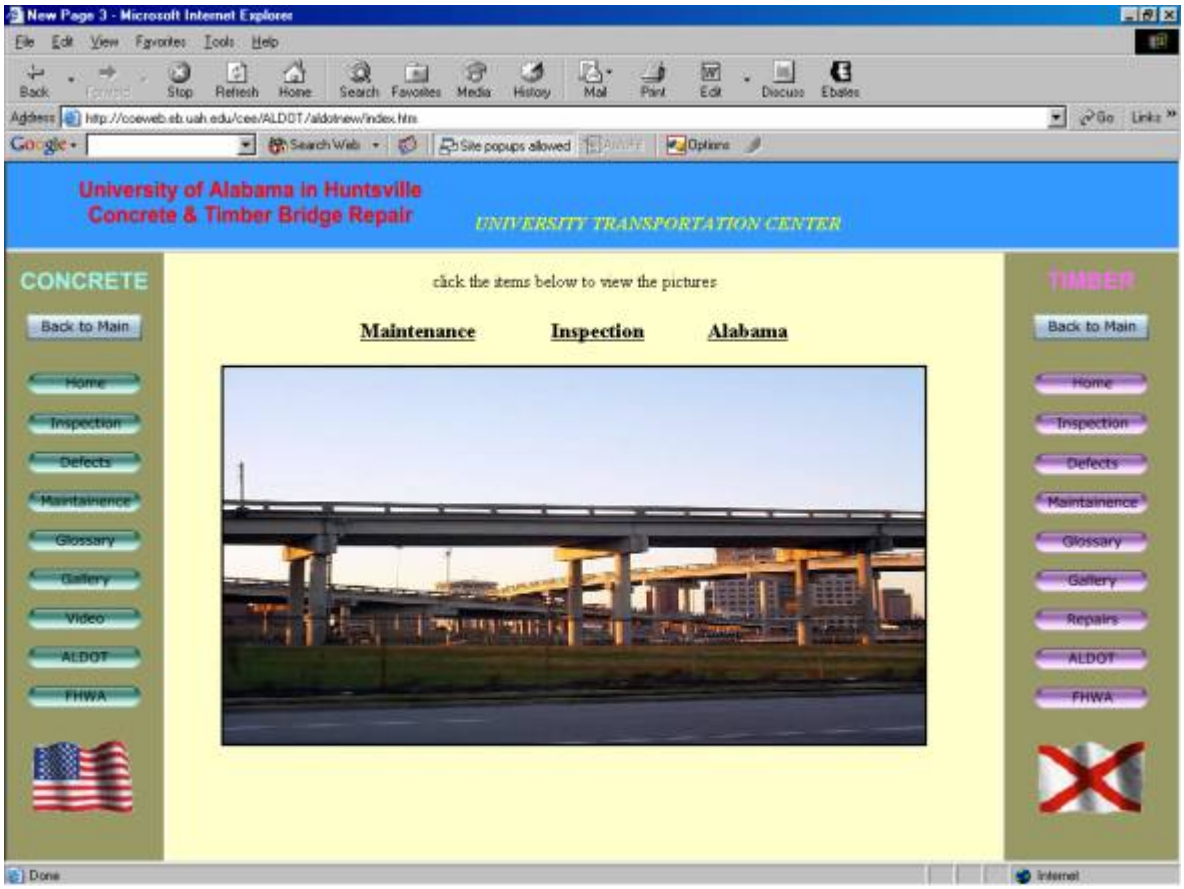

Figure 3-7. Concrete gallery containing photos of Alabama concrete bridges and work in progress

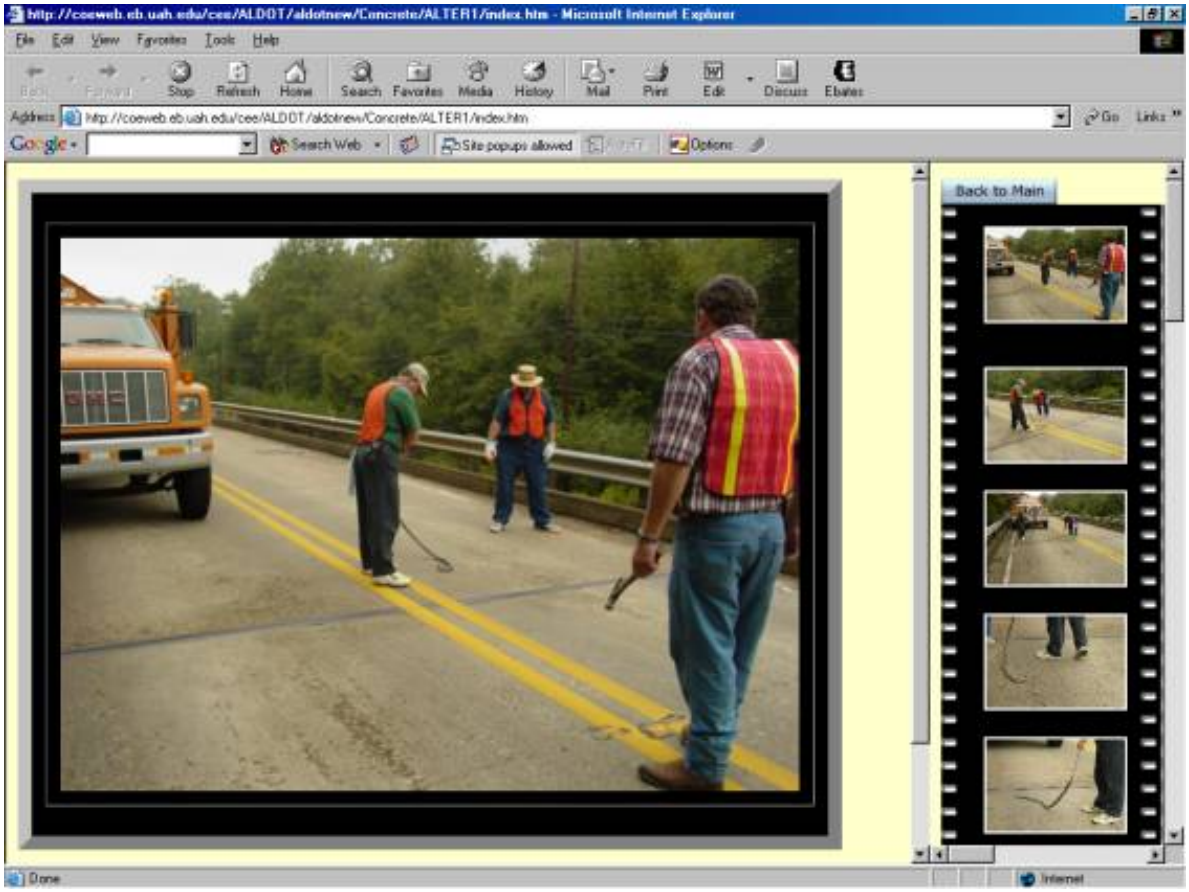

Figure 3-8. Photo of concrete bridge inspection in progress

Video

This section contains footage of several inspection and repair procedures in process (see Figure 3-9).

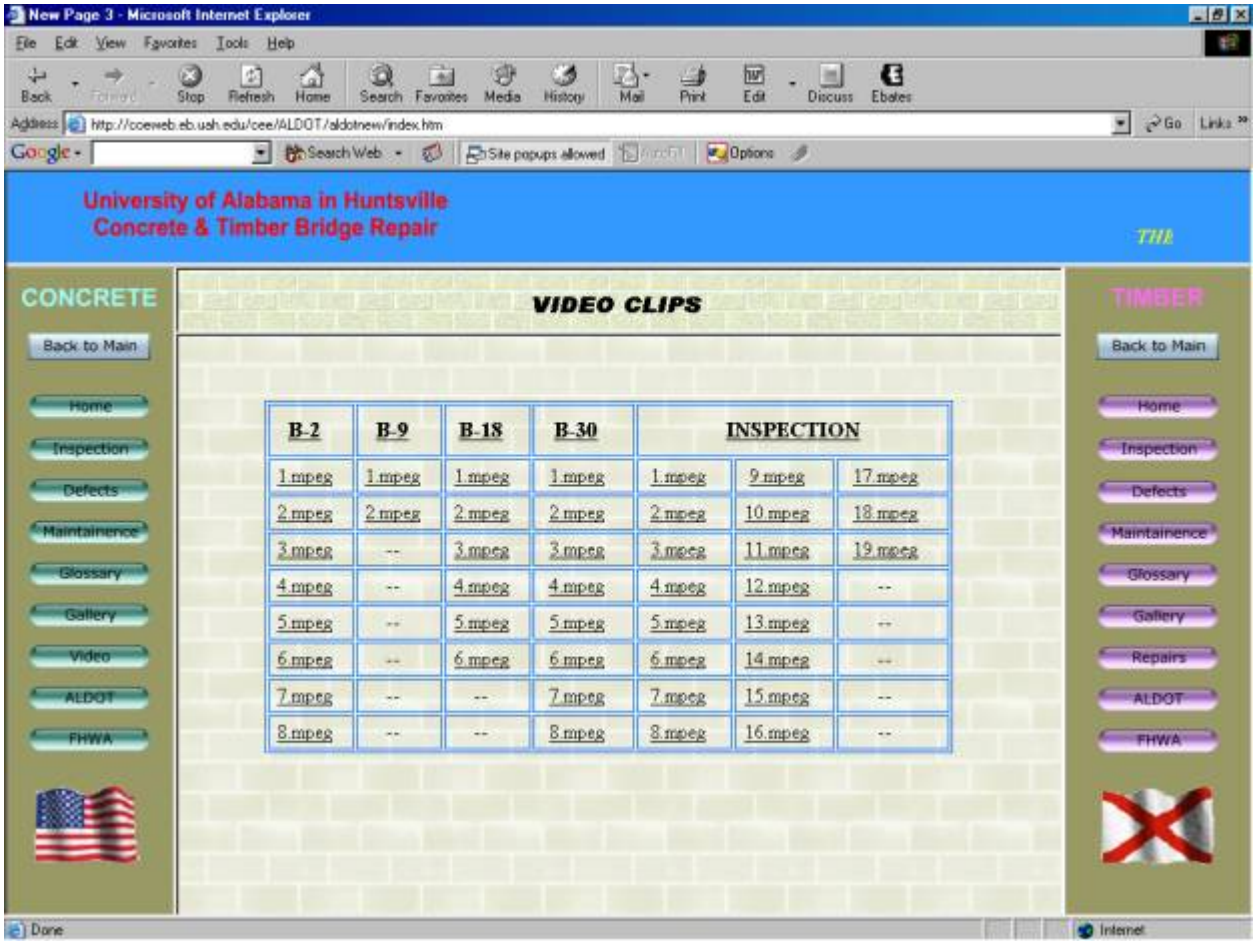

Figure 3-9. Video section containing clips of several maintenance and inspection procedures

Links to External Sites

External links take the user to the home pages of the ALDOT and Federal Highway Administration (FHWA) websites (see Figures 3-10 and 3-11).

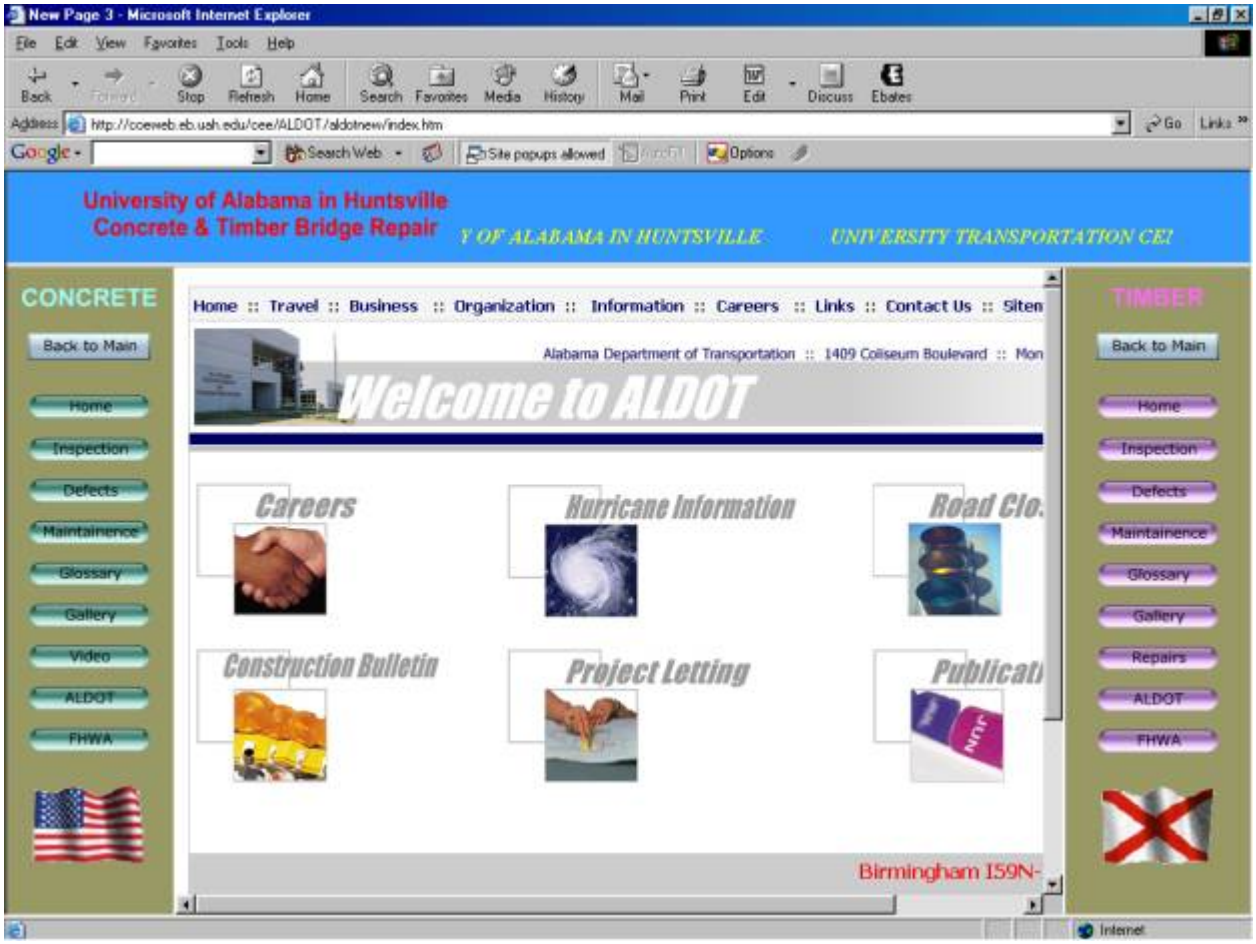

Figure 3-10. Main home page of the ALDOT web site accessed from the ALDOT link

Figure 3-11. Main home page of the FHWA web site accessed from the FHWA link

3.3 Timber

Home

This link takes the user to the timber bridge homepage, which includes a welcome greeting and a brief description of the purpose of the web site. A web search tool is also provided on this page, (see Figure 3-12).

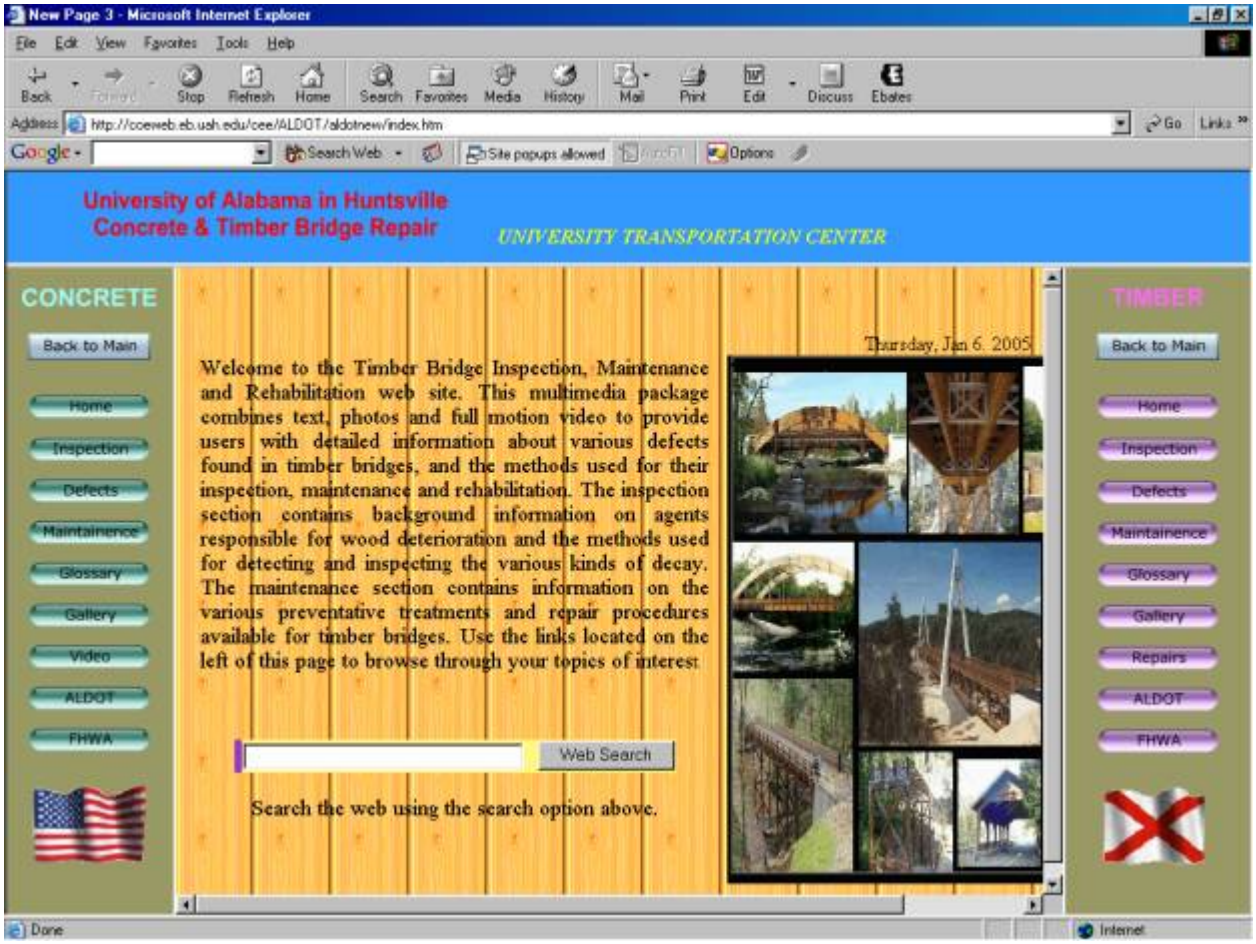

Figure 3-12. Main home page of the timber bridge web site accessed from the home link

Inspection

This section covers the fundamentals of timber bridge inspection for decay and deterioration. Timber bridge inspectors have the difficult task of accurately assessing the condition of an existing structure. They must understand the biotic and physical factors associated with wood deterioration as well as the relative rate at which these processes occur in a given environment.

Timber inspection is a learned process that requires some knowledge of wood pathology, wood technology, and timber engineering.

The inspection section identifies the agents of deterioration, and summarizes inspection methods and strength loss caused by decaying of wood. The homepage contains an introduction to timber bridge inspection and the following links: Index, Agents for Wood Deterioration, Inspection Procedures, and Strength Loss from Decay (see Figure 3-13). The index provides an outline of the information contained throughout the section (see Figure 3-14). Users may use this page to assist in finding specific content.

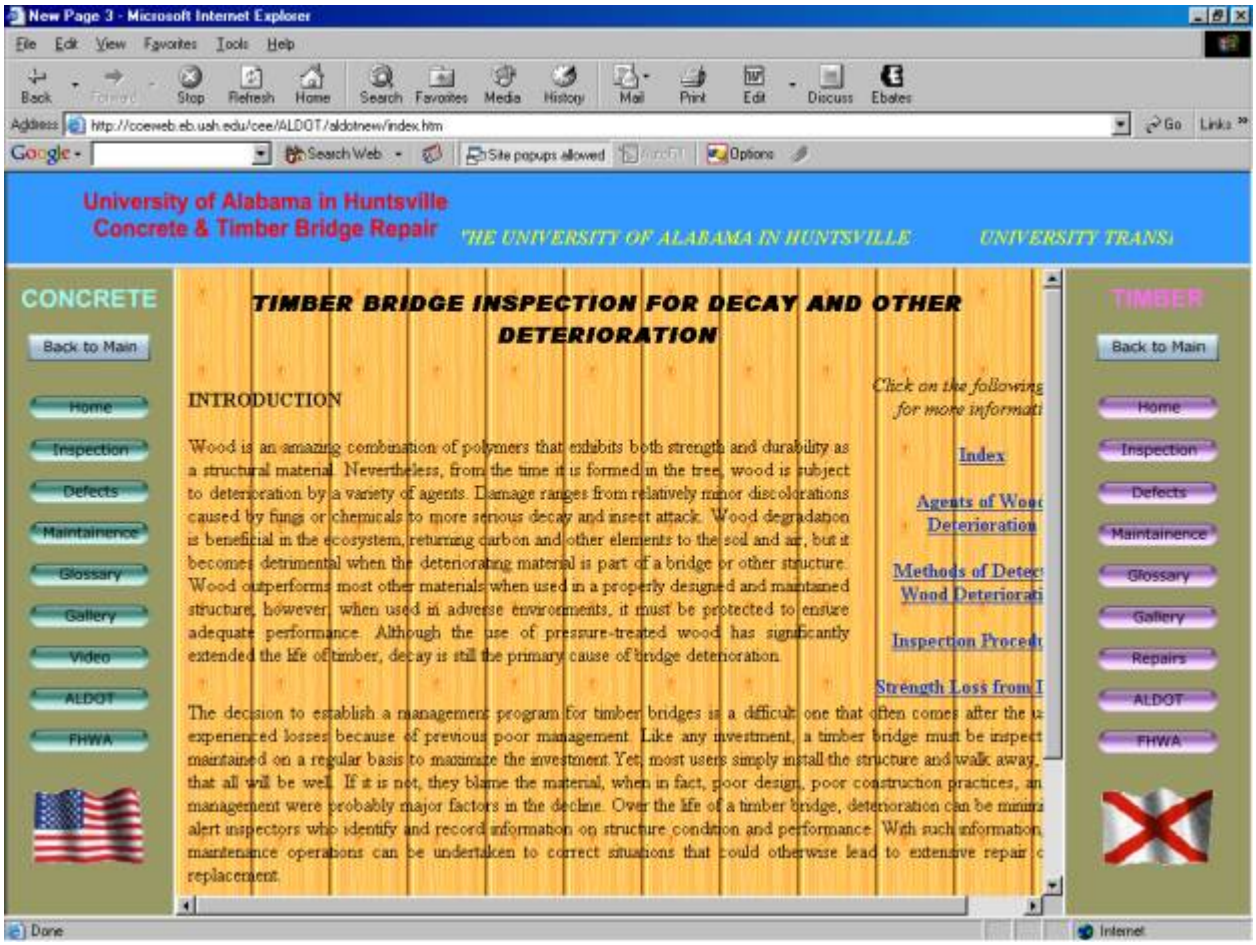

Figure 3-13. Inspection page of the ALDOT timber bridge repair website

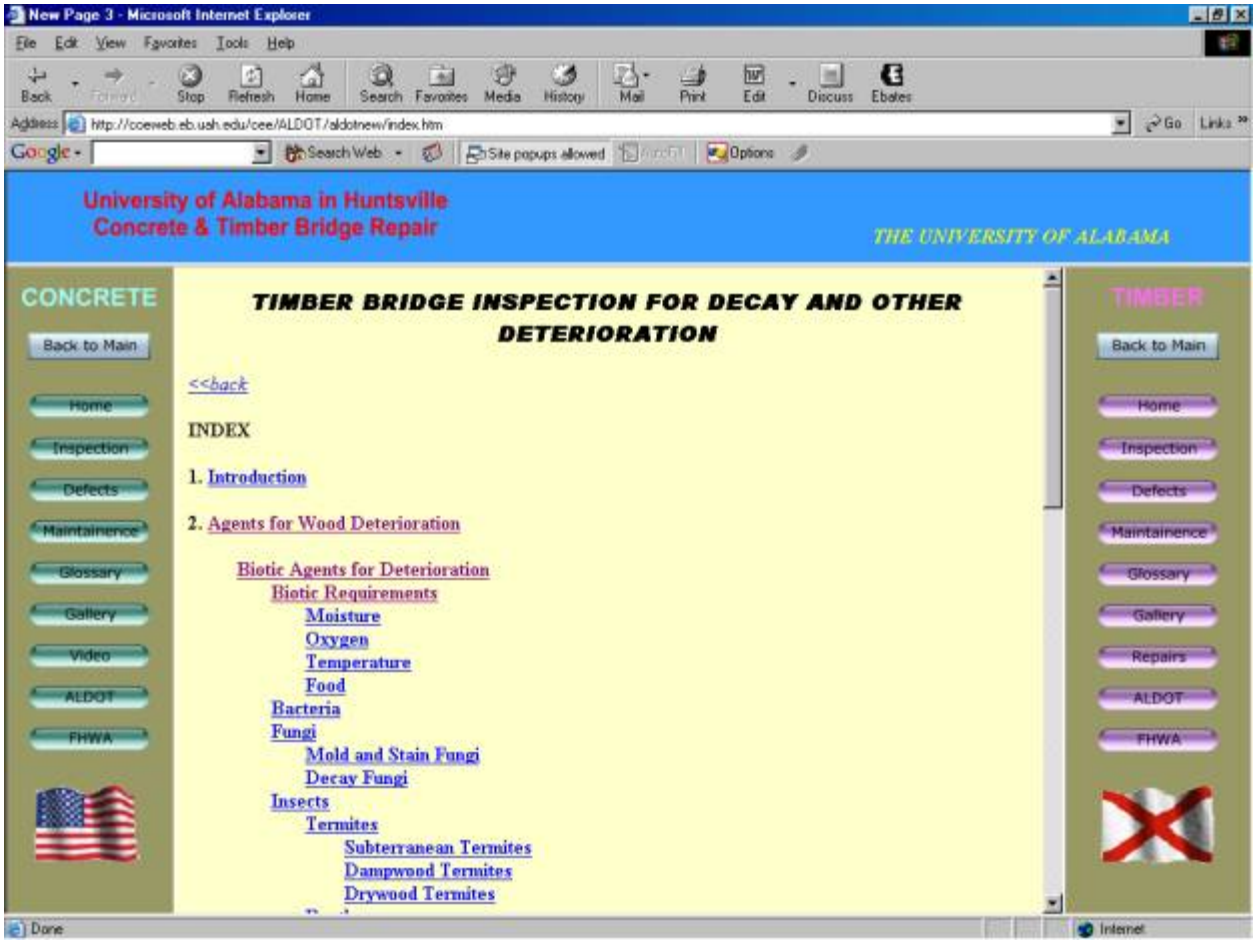

Figure 3-14. Inspection outline accessed from index link

A description of each link follows:

Agents for Wood Deterioration. This section contains detailed information about the various agents of wood deterioration. These agents are classified as biotic or physical and a link to each type is included on this page (see Figure 3-15). The inspector's familiarity with the agents of deterioration is one of the most important aids in effective bridge inspection. With this knowledge, inspection can be approached with a thorough understanding of the processes involved in deterioration and the factors that favor or inhibit its development.

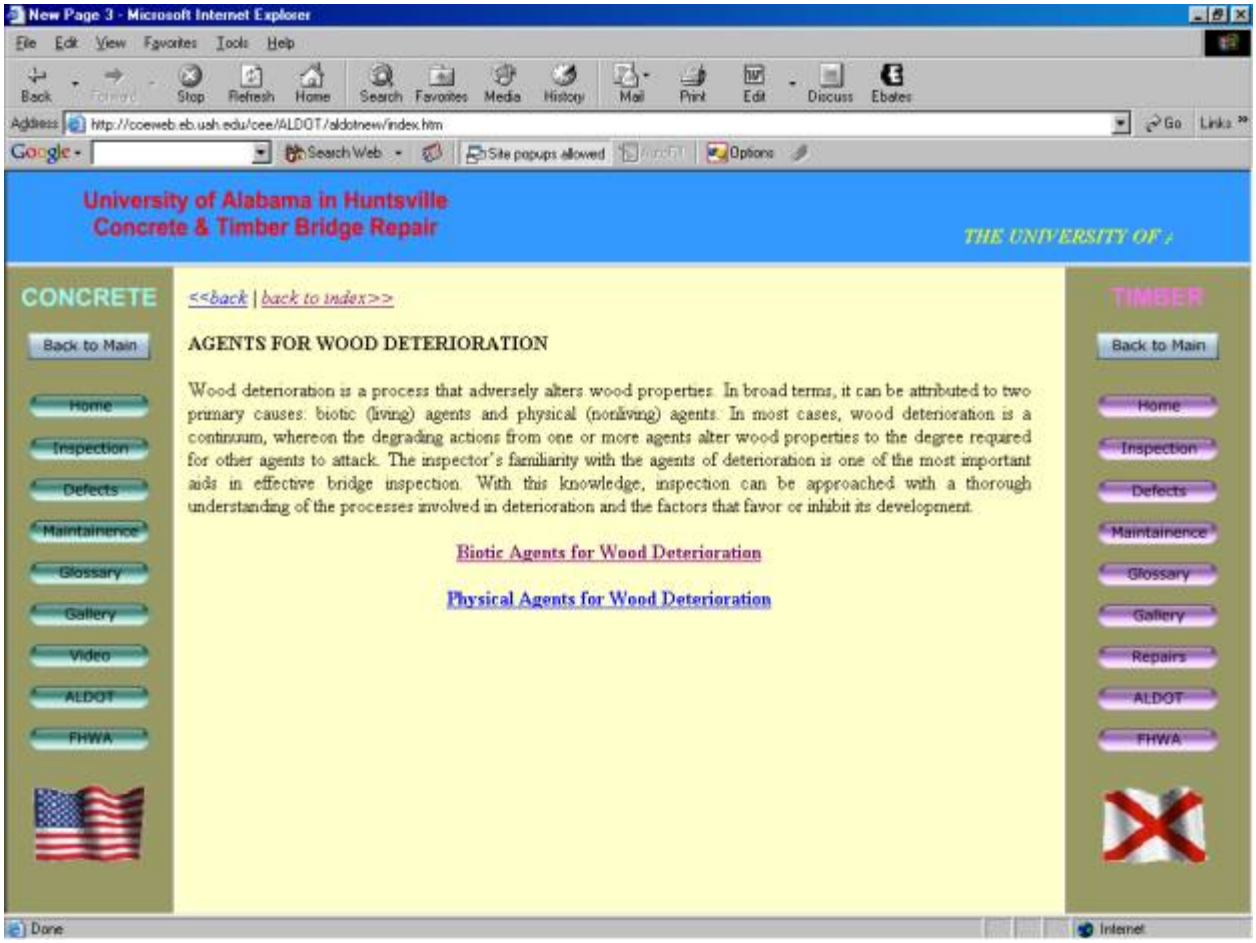

Figure 3-15. Web page introducing biotic and physical agents responsible for wood deterioration

Methods for Detecting Deterioration. This section provides detailed information about the different methods used for detecting deterioration. They are divided into two categories, those for exterior deterioration and those for interior deterioration. Both are thoroughly covered in this section.

Unfortunately, the ability to detect wood deterioration has lagged far behind the knowledge of deterioration mechanisms. As a result, inspection processes vary widely among regions, although the tools of the trade are fairly standard. There is no magic box that will accurately determine the condition of a given structure, but a number of tools used in combination can give a reasonable estimate of the amount and degree of wood deterioration present.

Three methods for detecting exterior deterioration are described, namely Visual Inspection, Probing and Pick Test. Each procedure is described in detail and photographs are included for illustrative purposes (see Figure 3-16).

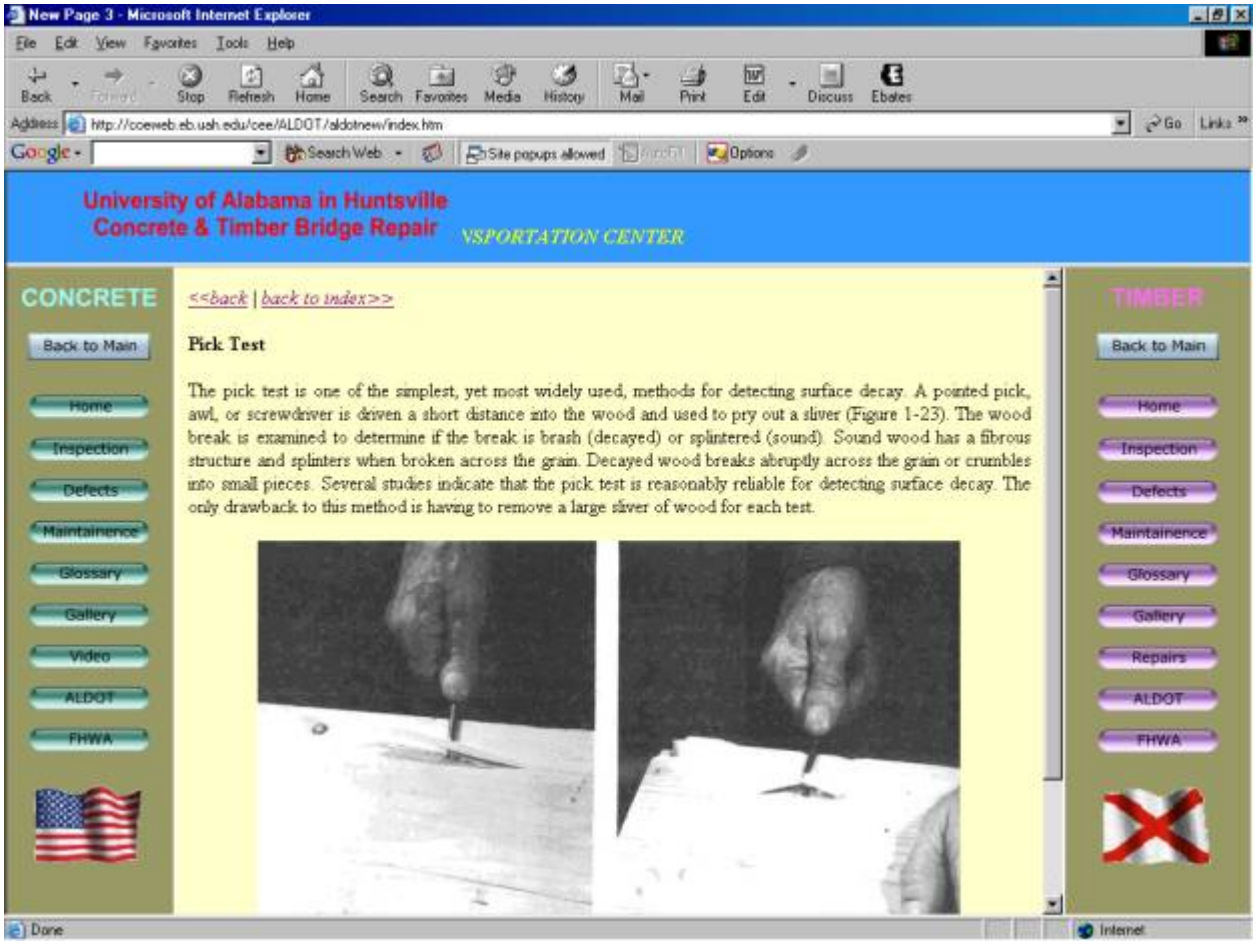

Figure 3-16. Web page containing instructions for conducting a pick test

Inspection Procedures. This section provides the inspector with an understanding of the general characteristics of deterioration and the concepts related to inspection procedures. Bridge inspection can be divided into three major steps: pre-inspection evaluation, field inspection, and preparation of reports and records. All three of these major steps are covered in full detail in this section of the module (see Figure 3-17).

Inspection procedures for timber bridges depend on variables such as the age and type of bridge and the environment in which the bridge is located. Therefore, detailed recommendations for specific procedures are somewhat impractical. In general, the inspector must thoroughly examine the bridge for decay and other deterioration and record findings in sufficient detail for an engineering appraisal. The specific procedures and methods, however, vary substantially from bridge to bridge. Although the procedures in each step vary among bridges, the basic process is the same.

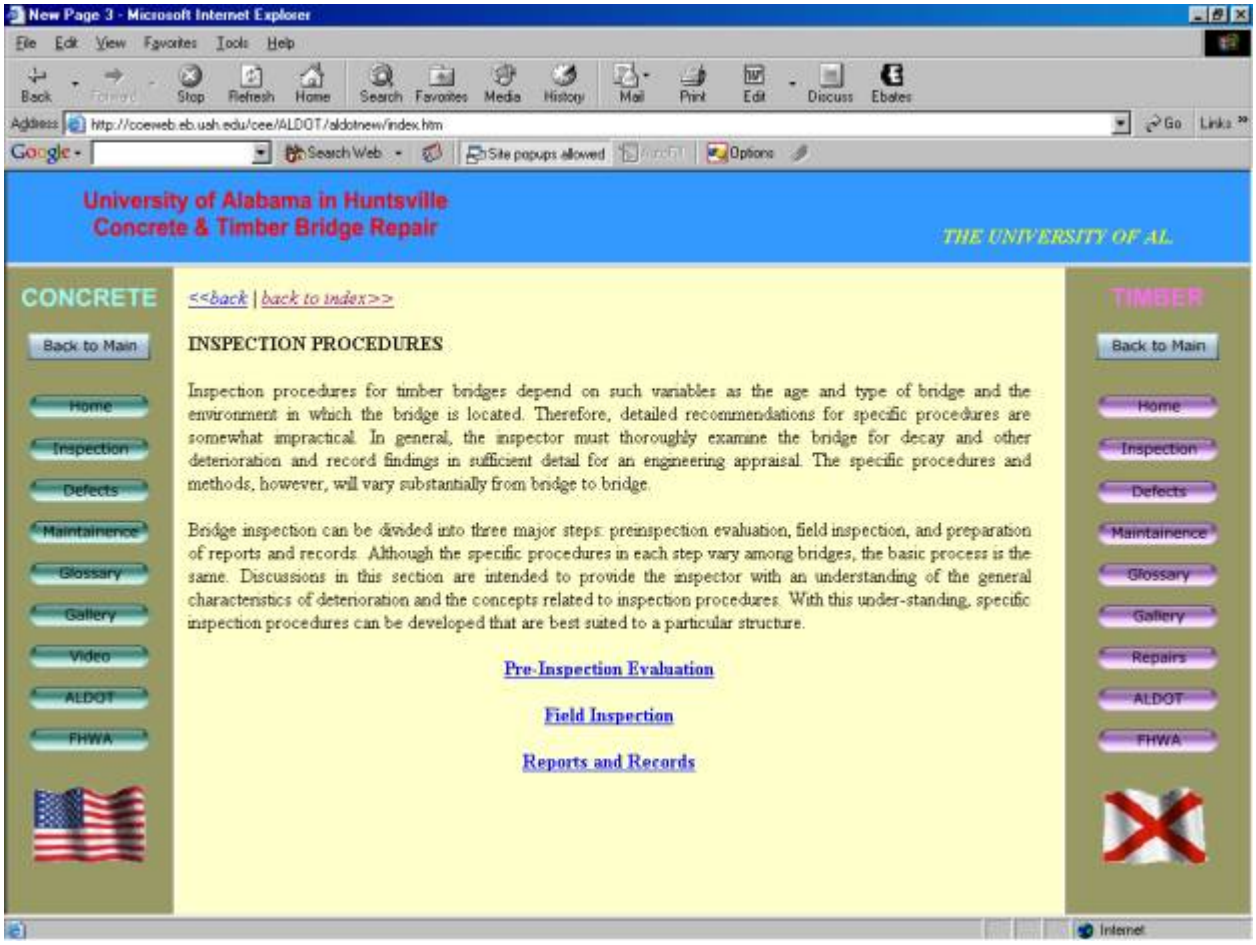

Figure 3-17. Inspection procedures web page

Strength Loss from Decay. This section describes different methods that can be used to accurately assess the strength loss caused by decay of timber bridge systems in different stages: advanced, intermediate or incipient (see Figure 3-18).

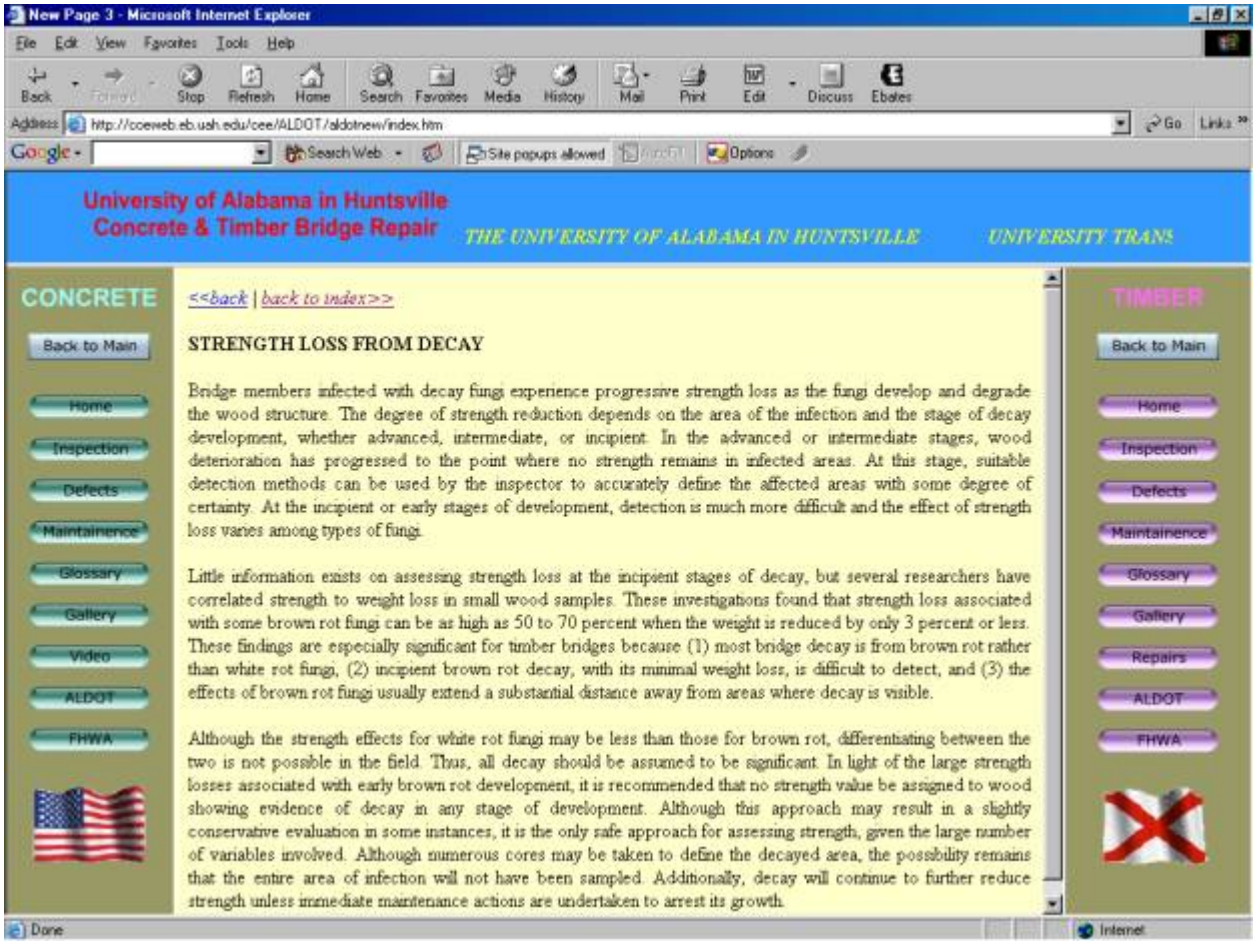

Figure 3-18. Strength loss from decay web page

Defects

The Defects section contains detailed information on the various types of defects commonly found in Alabama timber bridges and the damages to which they are subjected. Such defects include shakes, checks, splits, biodetoriation, fungus, insect infestation, marine borers, pine beetles and termites. The cause of each type of defect is described and photos are provided of existing defective structures. Figure 3-19 gives an illustration of how this information is presented on the web page.

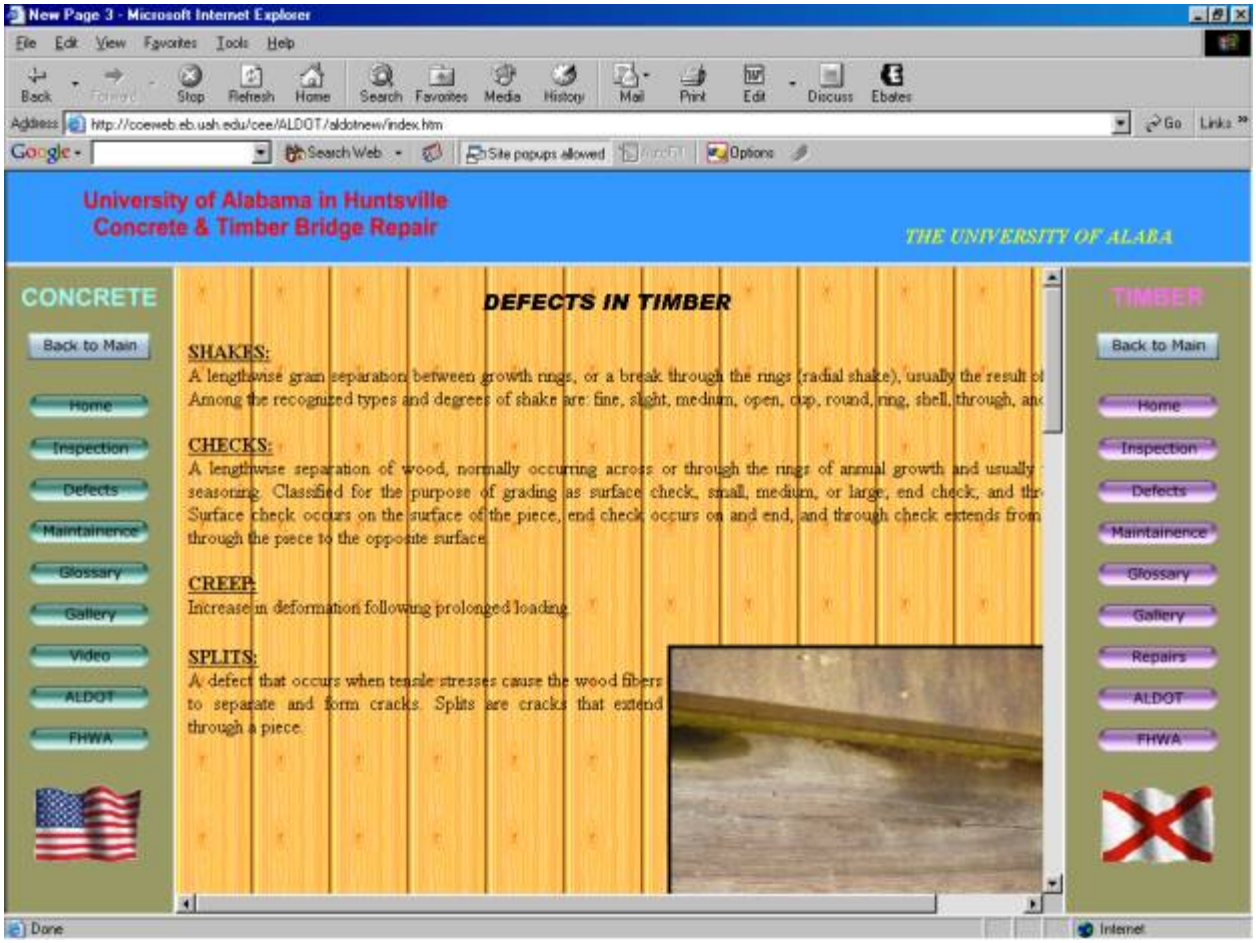

Figure 3-19. Sample of the information available on the timber bridge defects web page

Maintenance

This section of the module focuses on the current methods used for maintaining and repairing timber bridges. Because deficiencies develop from a variety of causes, it is impractical to address each type of potential problem. Rather, preventative and remedial methods that can be adapted to the specific circumstances of the structure are discussed.

The maintenance homepage contains an introduction to timber bridge maintenance and the following links: Index, Moisture Control, In-Place Preservative Treatment, Mechanical Repair, Epoxy Repair, and Component Replacement (see Figure 3-20). The index page outlines the content of this section with links enabling users to have quick access a specific topic of interest (see Figure 3-21). The next pages describe the topics.

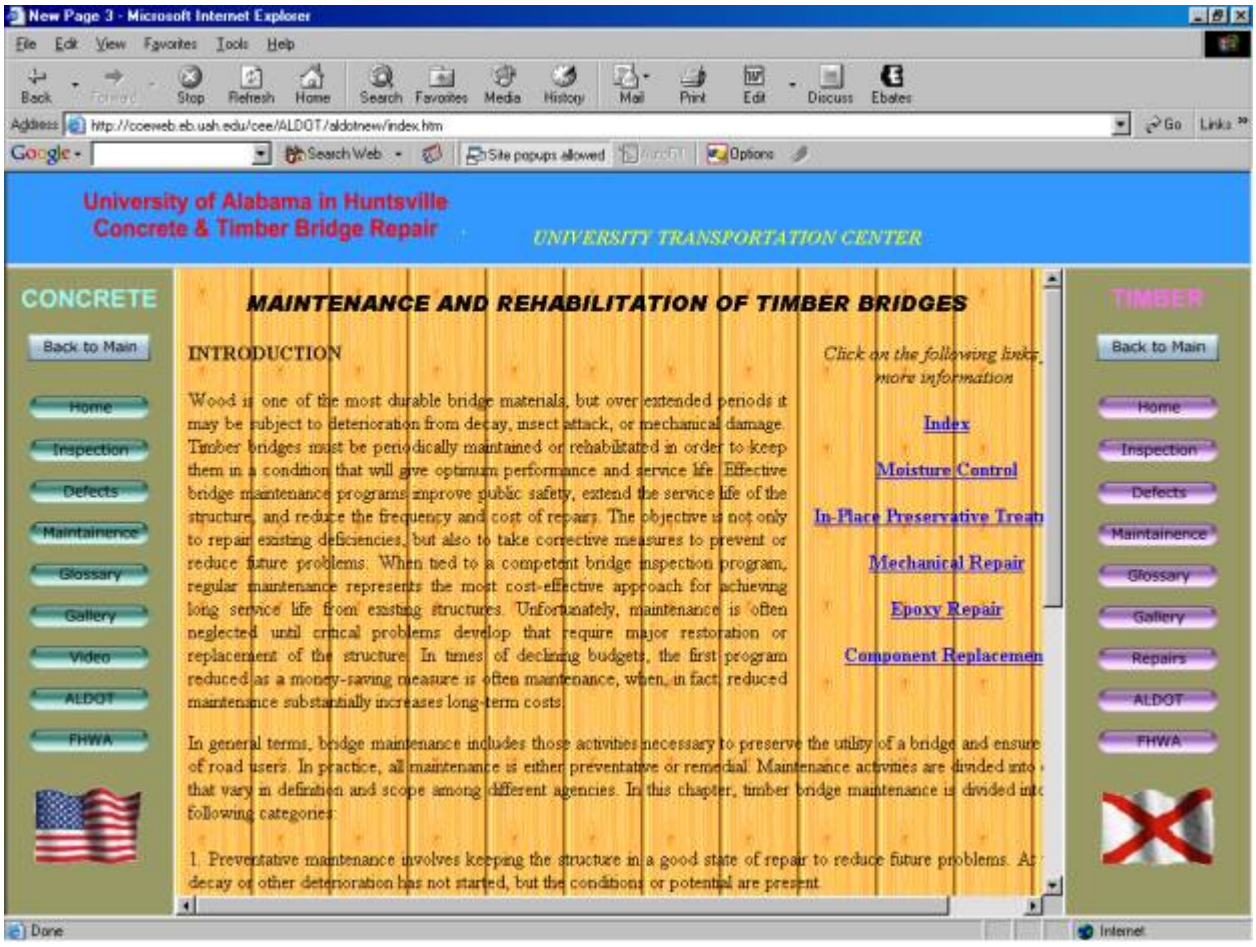

Figure 3-20. Maintenance homepage of the ALDOT timber repair website

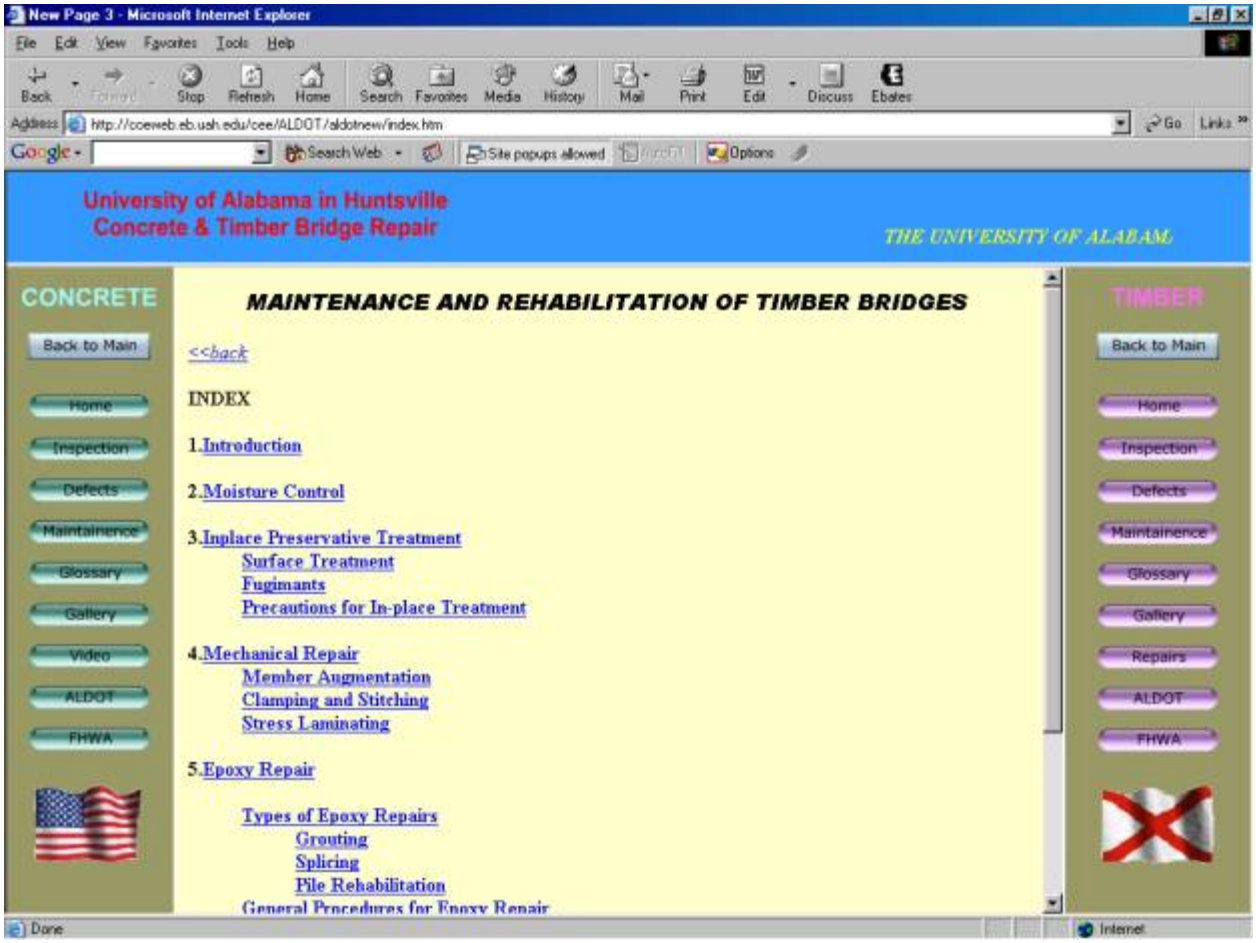

Figure 3-21. Maintenance outline accessed by index link

Moisture Control. This section describes the different techniques and methods used to control moisture in timber bridges (see Figure 3-22).

Moisture control is the simplest, most economical method of reducing the hazard of decay in timber bridges. It can be used as an effective and practical maintenance technique to extend the service life of many existing bridges.

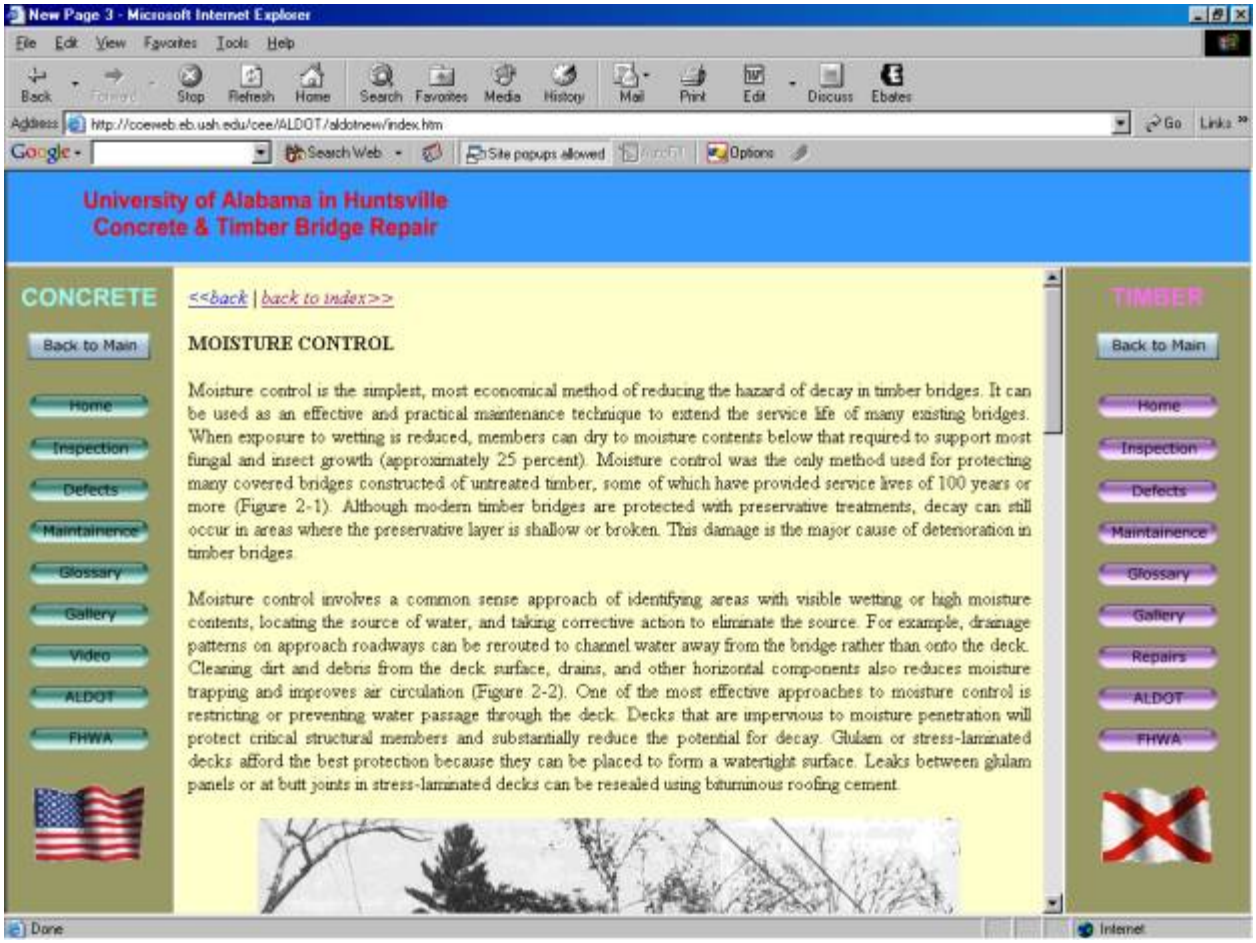

Figure 3-22. Sample of information available on moisture control web page

In-Place Preservative Treatment. This section describes the procedure for in-place preservative treatment. This treatment involves the application of preservative chemicals to prevent or arrest decay in existing structures. Two of the most common types of treatment are described in this section: surface treatments and fumigants (see Figure 3-23). Precautions for in-place treatment are also described in depth.

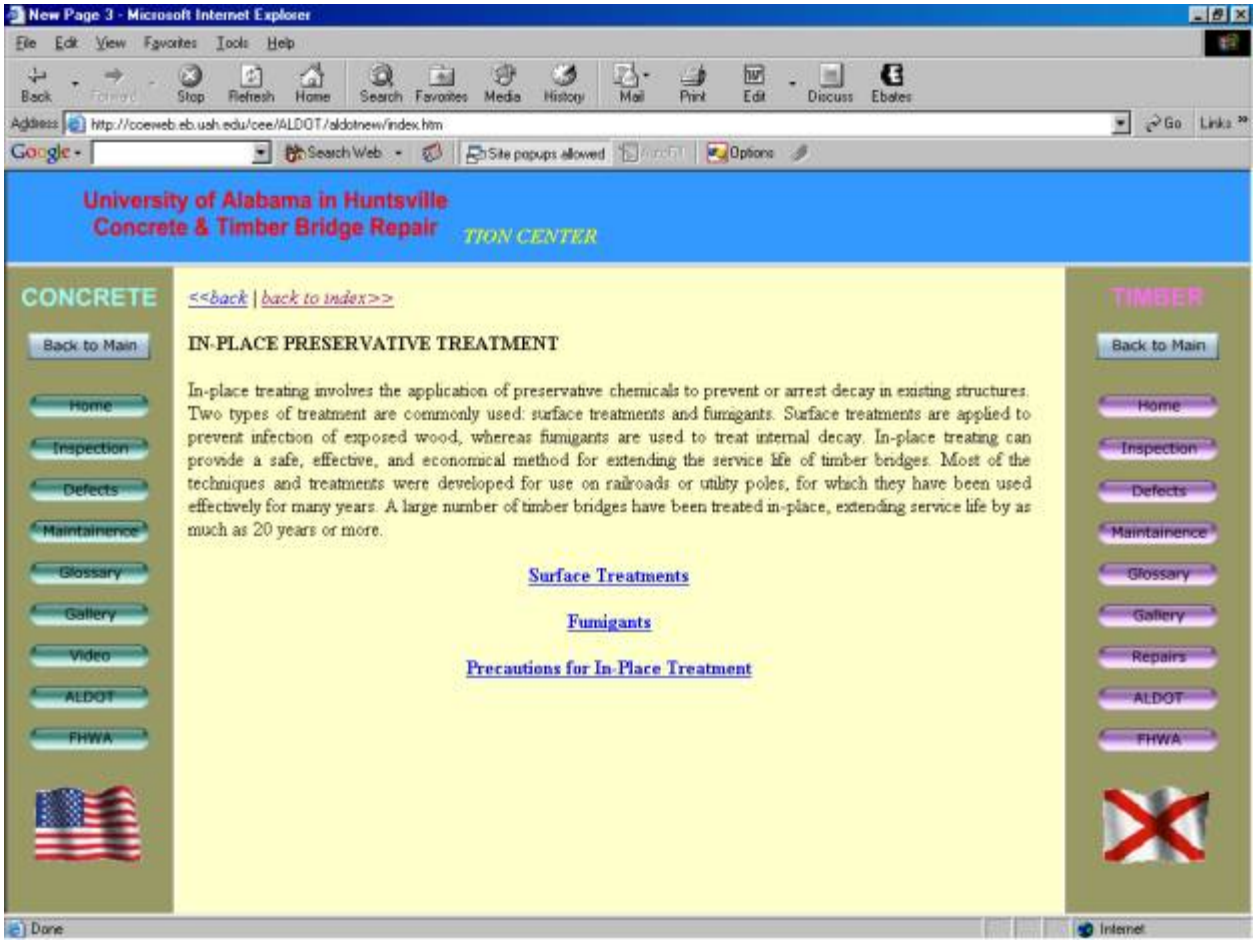

Figure 3-23. Sample of information available on the website for in-place preservative treatment

Mechanical Repair. This section describes mechanical repair methods. These methods use steel fasteners and additional wood or steel components to strengthen or reinforce members. The three methods of mechanical repair discussed in this section are member augmentation, clamping and stitching, and stress laminating (see Figure 3-24).

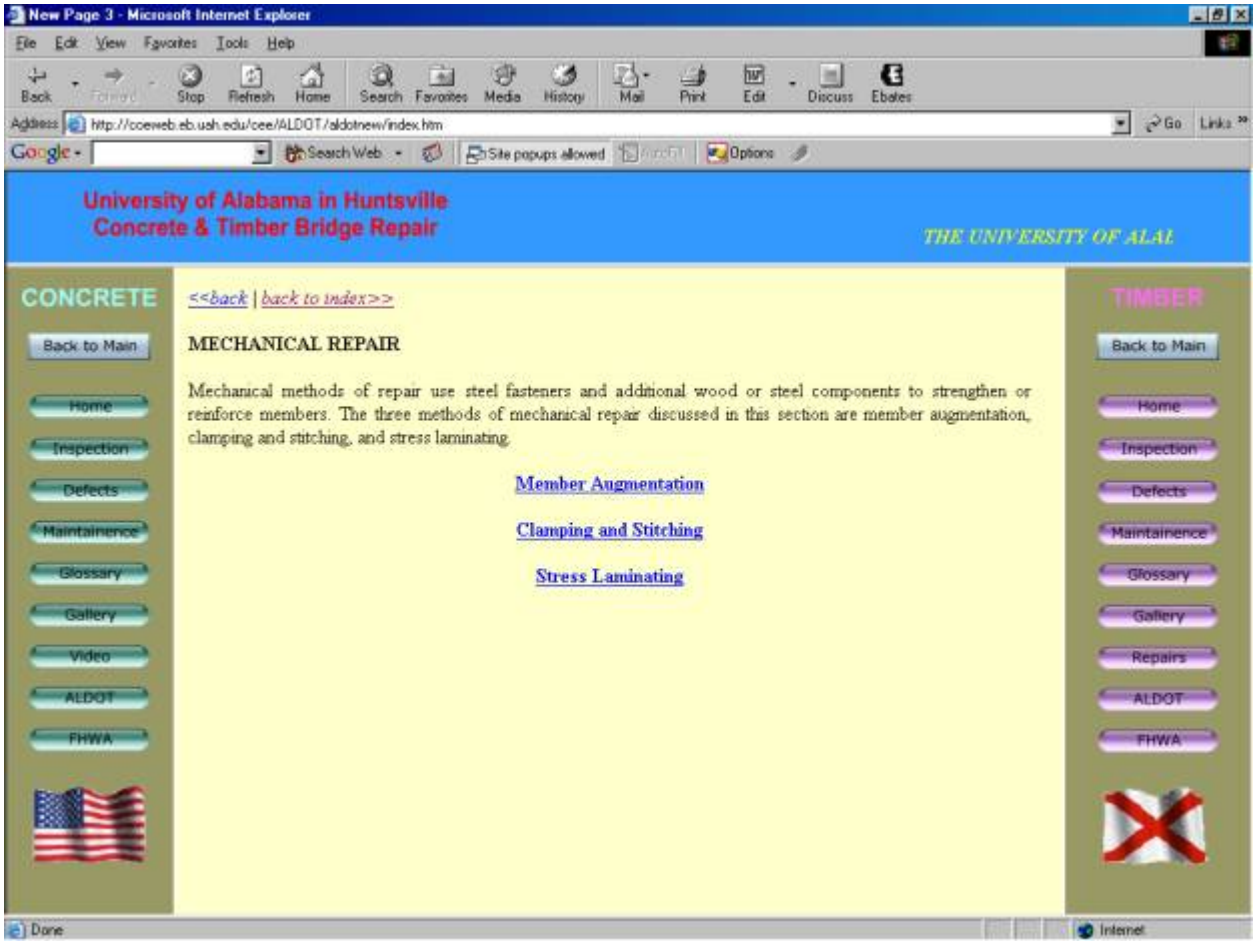

Figure 3-24. Sample of information available on the website for mechanical repair treatment

Epoxy Repair. This section describes epoxy repair methods. They consist of basic resins and resin-hardening agents that are blended in a liquid or gel (putty) form. When mixed, the epoxy compounds harden to form a solid, durable material that provides a high degree of adhesion to most clean surfaces.

This section of the module provides a comprehensive discussion of different types of epoxy repairs that are exercised by ALDOT and county engineers, and the general procedures required for these epoxy repairs (see Figure 3-25).

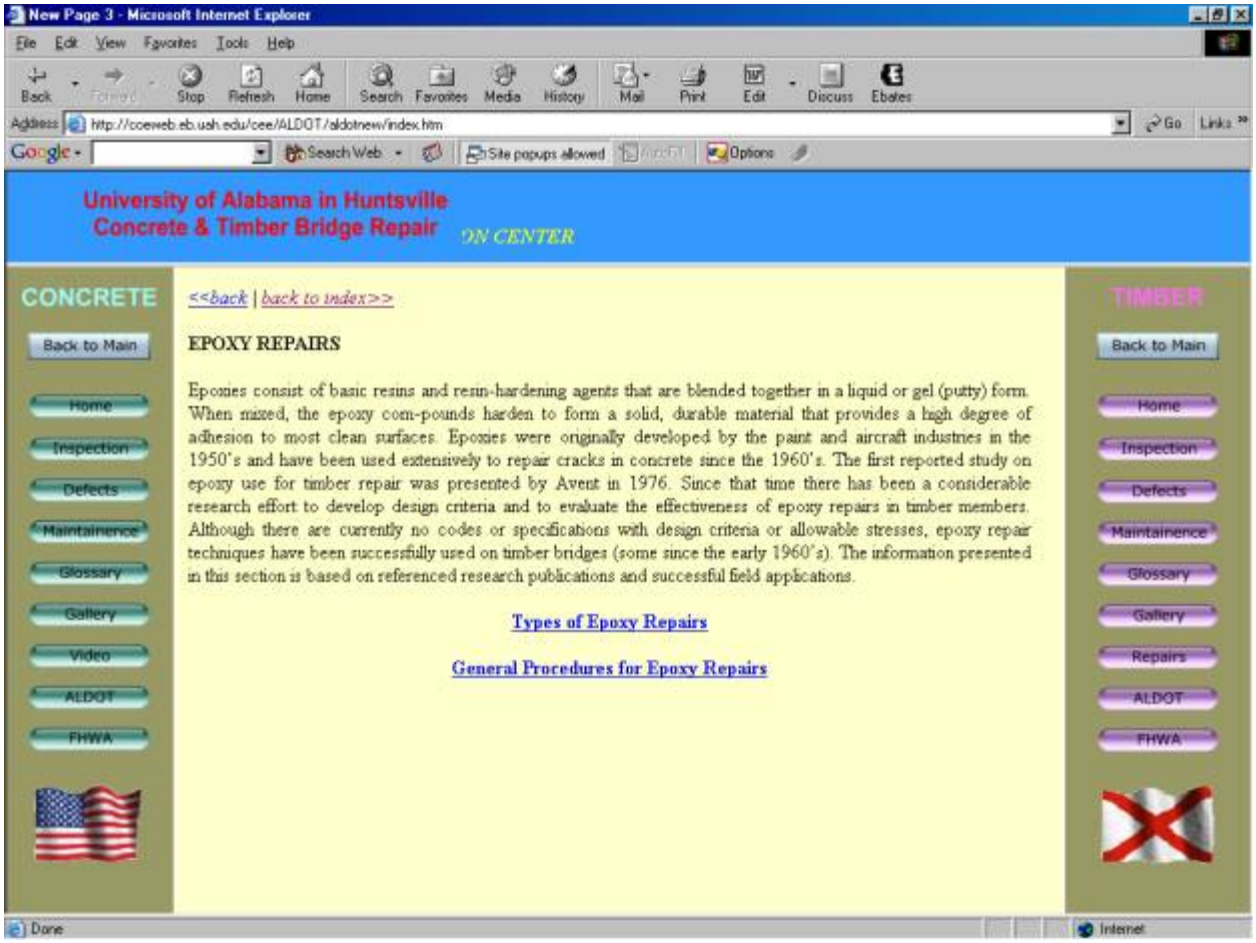

Figure 3-25. Sample of information available on the website for epoxy repair utilized by ALDOT

Component Replacement. This section describes the method of component replacement commonly used in situations where a lack of maintenance or other causes leads to deterioration so severe that replacement of the member is the only economically viable alternative. In these cases, the structure must be temporarily supported (when required), the old member removed, and a new one installed in its place (see Figure 3-26).

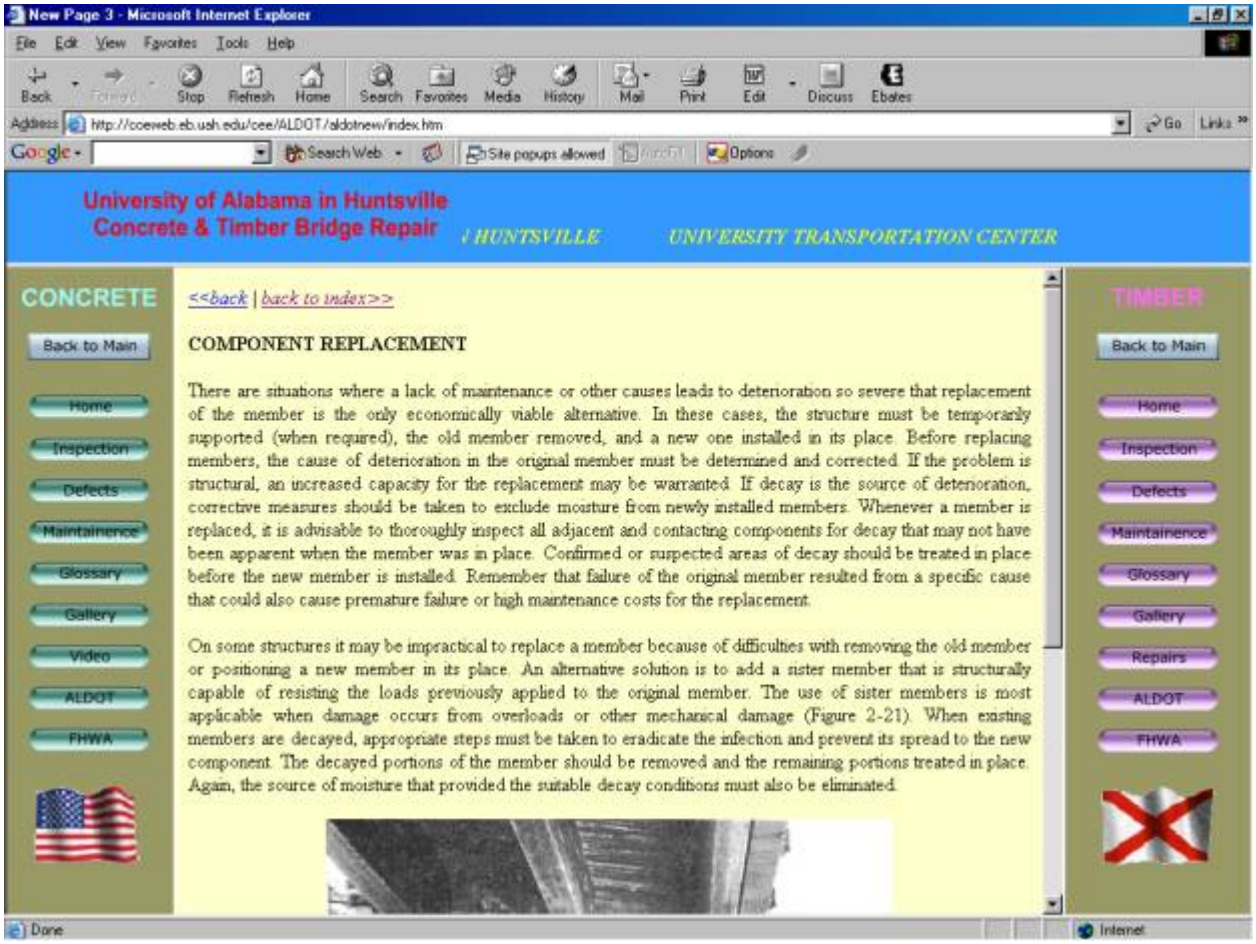

Figure 3-26. Component replacement for timber bridges described on the website

Glossary

This section provides a list of key words cited on the website, words that are relevant to timber bridges, and their detailed definitions (see Figure 3-27).

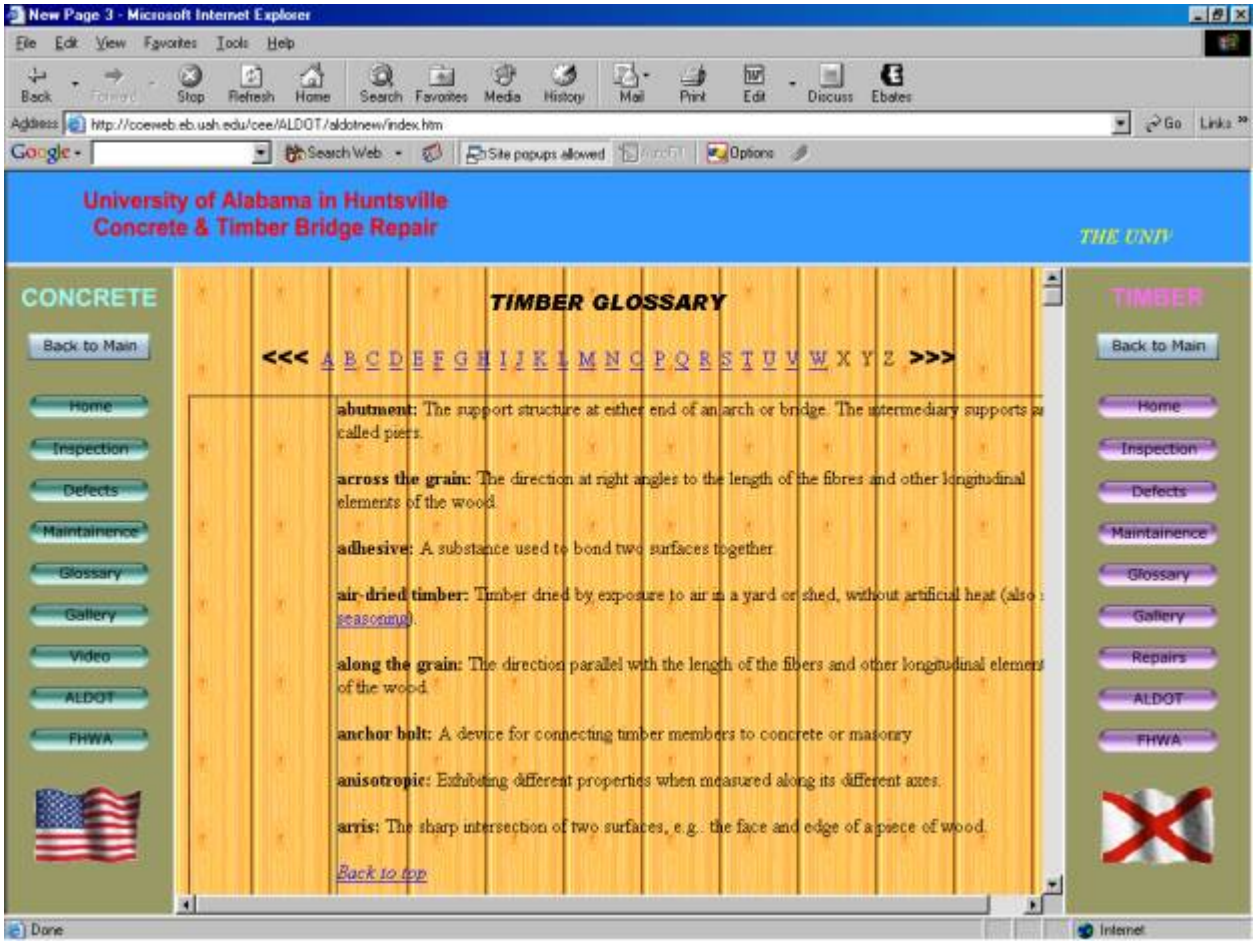

Figure 3-27. Glossary page of the timber bridge repair web site

Gallery

The gallery section contains pictures of several timber bridges situated across the United States. It also contains photos of the various defects and repair procedures for timber bridges (see Figures 3-28 and 3-29).

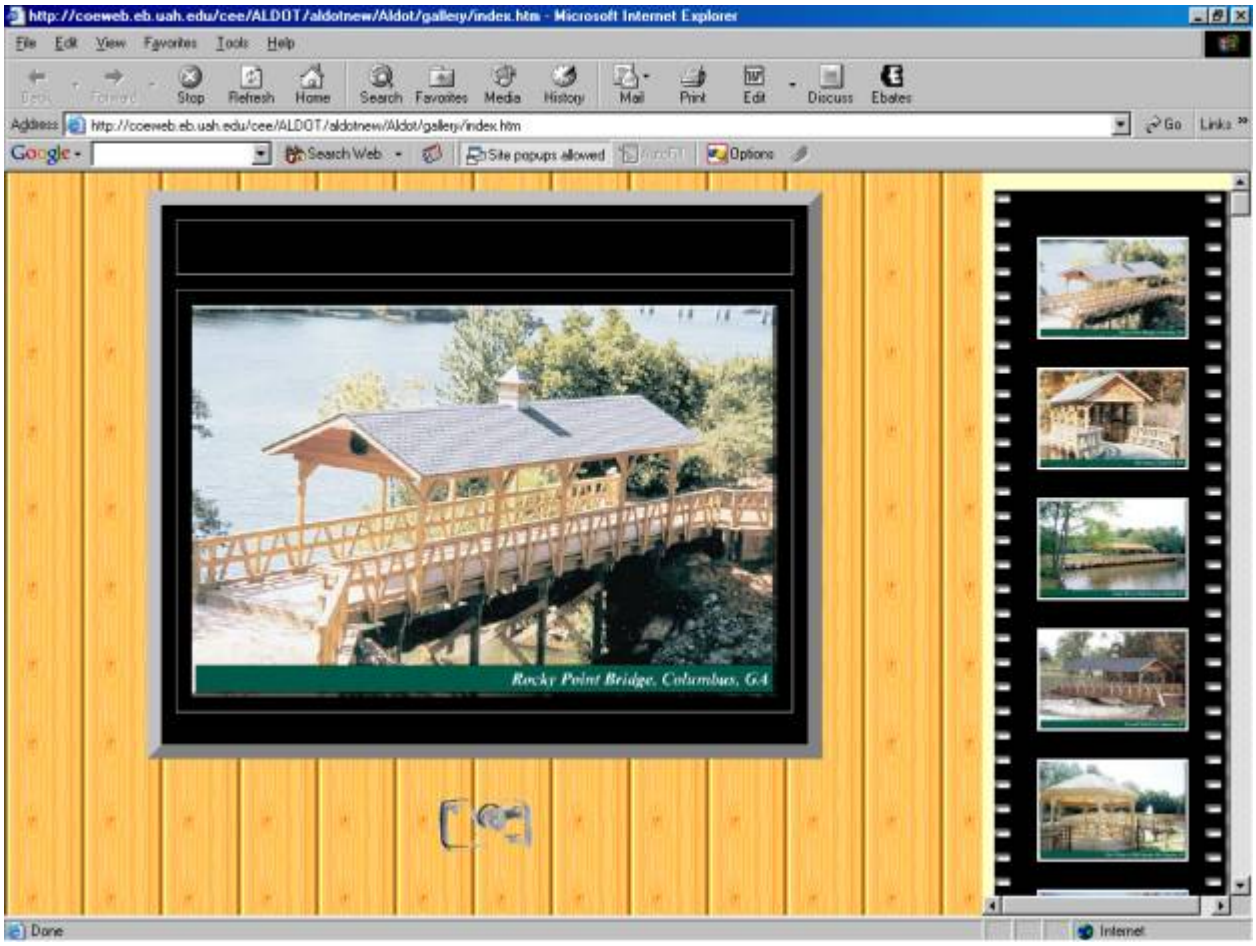

Figure 3-28. Web page displaying timber bridges across the United States

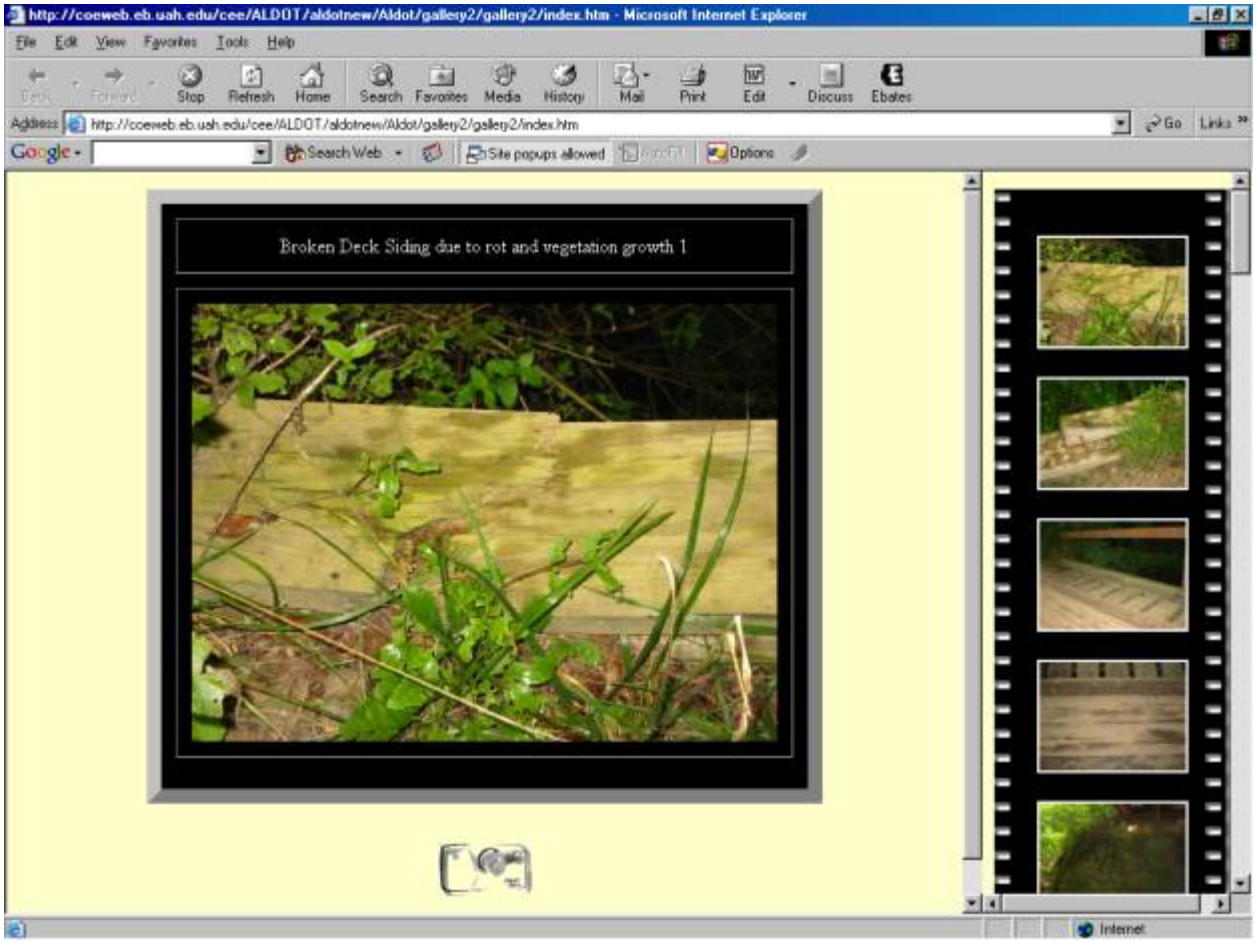

Figure 3-29. Photograph of defective bridge located in Alabama

Repairs

This section provides details on some Alabama bridges that have been inspected and repaired by ALDOT and county engineers (see figure 3-30). This section should be especially helpful to new employees who are in the learning process as bridge inspectors or maintenance/repair personnel.

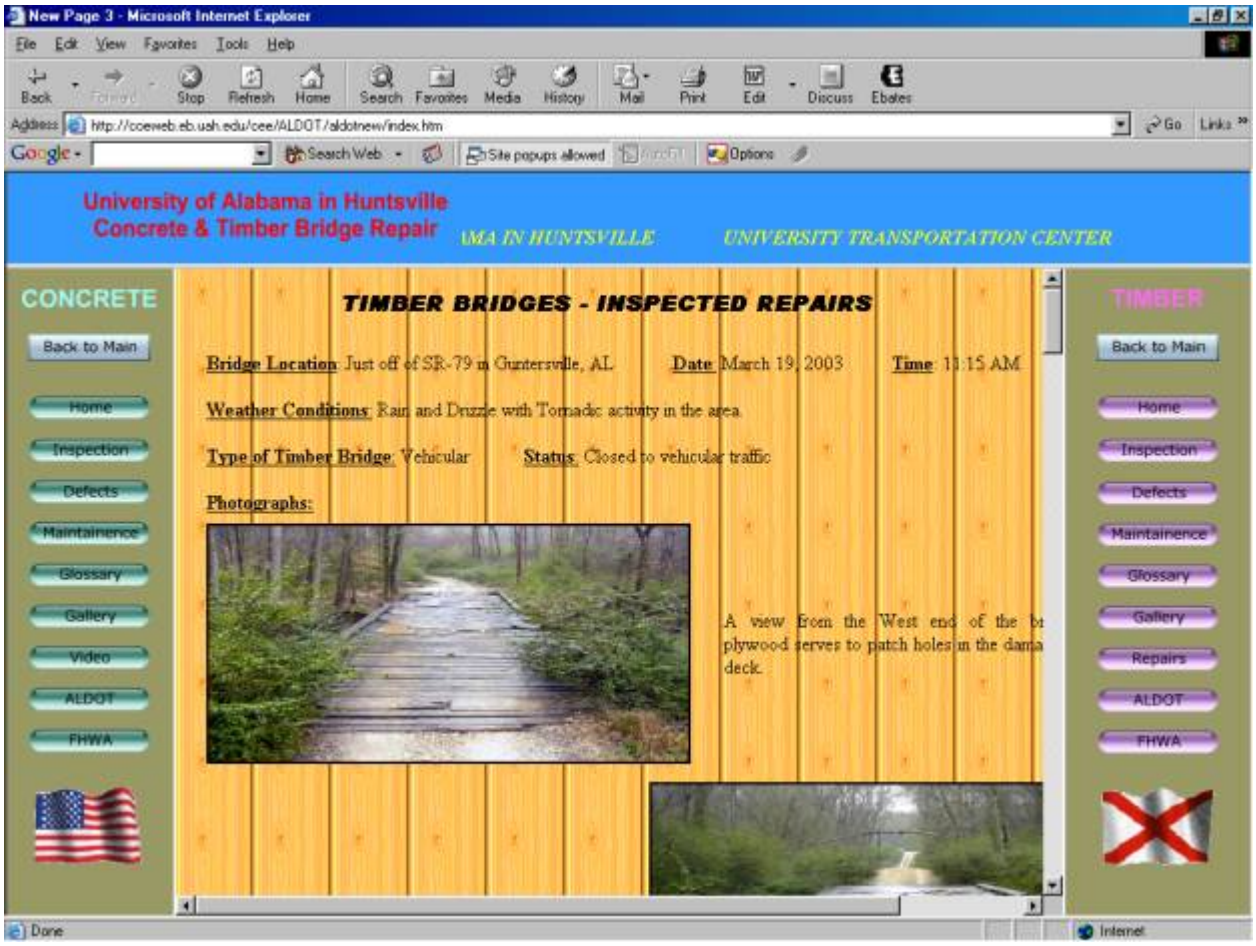

Figure 3-30. Timber bridge repair web page

4.0 Conclusions

The objective of this project was achieved and a web site and CD-ROM were developed using a wide range of multimedia resources. This module provides quick access to detailed information on the assessment and repair procedures currently used by the Alabama Department of Transportation. This module contains two main sections, namely concrete and timber. The concrete part provides guidelines for conducting inspection and maintenance to concrete bridges and the timber part provides such guidelines for timber bridges.

The multimedia technology that was developed in this study is advantageous in many ways. Step-by-step details accompanied by photographic illustrations provide users with a wealth of information that is easy to understand. Also this type of technology is easily adaptable and extensible to future changes and can therefore be easily updated whenever procedures and practices are modified. These advantages make the module an ideal training tool for engineers.

The multimedia web site will be maintained in the Civil & Environmental Engineering Department at The University of Alabama in Huntsville, where the Principal Investigator will periodically update it.

5.0 Recommendations

Three of the nine divisions of ALDOT are responsible for bridge maintenance work throughout the State. It is costly for ALDOT to undertake work far away from these three divisions. This tool can be implemented to provide ALDOT and county engineers of all divisions with training on the various remedial procedures, enabling them to undertake simple repair work on sites located within close proximity of their division or county. Once this tool is handed over to ALDOT, maintaining and updating the web site and the CD-ROM in response to future changes in their inspection and maintenance procedures will be ALDOT's responsibility.

6.0 References

Xanthakos, P., “Bridge Strengthening and Rehabilitation,” Prentice Hall, 1996.

Ritter, A. M., “Timber Bridges: Design, Construction, Inspection, and Maintenance”, USDA Forest Service, FPL, 1992.

Bridge Inspection Manual, Maintenance Bureau, 1997 Edition, Alabama Department of Transportation, Montgomery Alabama. *(BI-5 Bridge Inspection Condition Report, BI-6 Structural Inventory and Appraisal, BI-9 Bridge Maintenance Needed, BI-10 Bridge Maintenance Performance Card, and BI-11 Secondary Road Bridge Maintenance Performance Card)*