Asset Management: Bridge Assessment Annual Update

Annual Bridge Condition Update

WSDOT reports on the condition of its bridges to the Office of Financial Management (OFM) in accordance with reporting standards set by the Governmental Accounting Standards Board (GASB). The rating system for bridges follows criteria set for the country as a whole by the Federal Highway Administration (FHWA). The Governor's Cabinet Strategic Action Plan goal is to maintain 97% of all bridges statewide at a condition rating of good or satisfactory (fair). This measure is consistent with data provided in the Comprehensive Annual Financial Report (CAFR), which groups together the number of bridges, ferry terminal structures, and culverts. Less than three percent of bridge structures (2.6%) had a condition rating of "poor". No bridge that is currently rated as "poor" is unsafe for public travel.

New to this edition of the *Gray Notebook*, an analysis of bridge structural condition by deck area indicates that 94% (41,616,238 sq. ft.) of WSDOT's total bridge deck area (44,225,455 sq. ft.) is accounted for by bridges in good or fair condition. Bridge structures in poor condition represent approximately 6% (2,609,217 sq. ft.) of WSDOT's total bridge deck area. Nearly 48% of the

Inventory of WSDOT Bridge Structures

As of June 30, 2007

	No. of Bridges	Square Feet
Vehicular Bridges greater than 20 feet in length[1]	2,990	43,984,312
Structures Less than 20 Feet in Length	325	n/a
Border Bridges (maintained by Border State)	6	n/a
Culverts greater than 20 feet in length	89	n/a
Pedestrian Structures	59	295,690
Tunnels and Lids	39	n/a
Ferry Terminal Structures[2]	45	248,443
Buildings (I-5 Convention Center)	1	n/a
Railroad Bridges	5	n/a
Total of all Structures	3,559	44,528,445

Source: WSDOT Bridge Office
[1]The Comprehensive Annual Financial Report (CAFR) reports 3,110 which includes culverts and passenger ferry terminals
[2]CAFR reports only the number of Ferry Terminal Structures that carry vehicular traffic only

Bridge Condition Ratings and Safety

The Federal Highway Administration (FHWA) requires each state to provide assessments on each bridge to determine structural and functional adequacy. Inspectors look at the deck (i.e., the road), the superstructure (the support beams that hold up the deck), and the substructure (the piers and columns that make up the foundation). Structural assessments of these elements are the basis for condition ratings to determine whether a bridge should be classified as structurally deficient (SD). A functional obsolete (FO) rating is assessed by comparing a bridge's as-built configuration to current standards and demands. Teams evaluate the load-carrying capacity strength, height clearance, waterway adequacy, and roadway alignment leading to and from the bridge.

There are 7,548 state and local bridges in Washington, of which 1,634 (26.7%) were rated as SD/FO. Of those, 381 bridges statewide were rated structurally deficient. As of December 2006, of 3,083 total WSDOT owned bridges, 107 (3.4%) were rated as structurally deficient by FHWA. For more information about SD/FO Bridges, see page 73.

The WSDOT bridge condition ratings reported in the *Gray Notebook* focus on the superstructure and substructure when evaluating the number of bridges in "Good", "Fair", or "Poor" condition. Using this standard, 2.6% of WSDOT bridges are currently in poor condition. This differs from FHWA, which includes deck condition, in addition to superstructure and substructure conditions, in determining SD/FO ratings. Condition ratings for the superstructure, substructure, and deck range from 0 (failed condition) to 9 (excellent condition). Condition ratings of 4 and below indicate poor or worse conditions and result in structural deficiencies. No WSDOT bridge has a condition rating of less than 3 (serious condition). A bridge with a condition rating of 3 is defined as one where loss of section, deterioration, spalling or scour have seriously affected primary structural components. If any bridge has a condition rating of 2 or less, it is closed to traffic.

Bridge Structural Condition Ratings

Condition Ratings by Fiscal Year (Based on the Number of Bridges)

Category	Description	2001	2002	2003	2004	2005	2006	2007
Good	A range from no problems to some minor deterioration of structural elements.	85%	87%	86%	87%	89%	88%	88%
Fair	All primary structural elements are sound but may have deficiencies such as minor section loss, deterioration, cracking, spalling, or scour.	11%	10%	11%	10%	9%	9%	9%
Poor	Advanced deficiencies such as section loss, deterioration, cracking, spalling, scour, or seriously affected primary structural components. Bridges rated in poor condition may have posted truck weight restrictions.	4%	3%	3%	3%	2%	3%	3%

Source: WSDOT Bridge Office. Data as of June 30 of each calendar year

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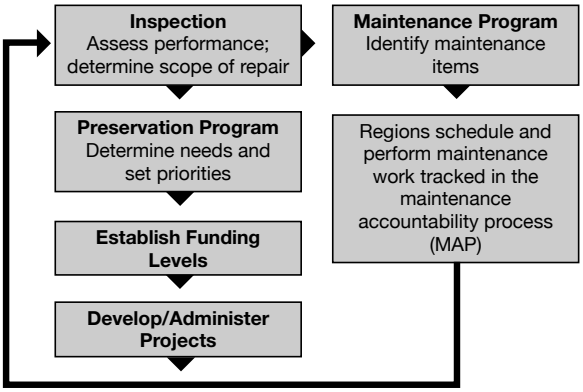
WSDOT Preservation Program Overview

Bridge repair needs are identified through the inspection program. Engineers review repair options and determine if the repair can be achieved within the scope of maintenance activities as part of the Management Accountability Process. If the repairs are of a more complex nature and cannot be addressed through maintenance activities, the issue is addressed through the bridge preservation program. The bridge preservation program determines the scope of the project needed to address the issue, the funding level required to complete the project, and prioritizes projects for completion.

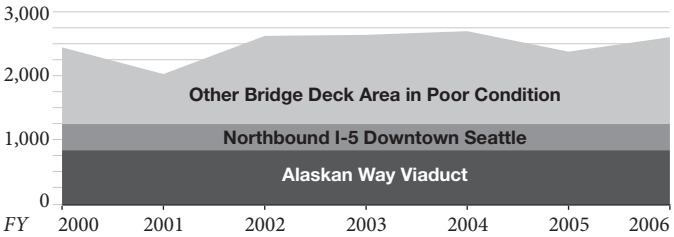


bridge deck area for all bridges in poor structural condition is accounted for by two bridge structures—the Alaskan Way Viaduct (849,960 sq. ft.) and Northbound I-5 (407,750 sq. ft.), both in downtown Seattle. However, the Spokane Street Bridge Repair Project in August 2007 will result in a condition upgrade for the Northbound I-5 Viaduct from poor to fair or good.

As a bridge's condition deteriorates it may be necessary to limit the weight of trucks that can pass over the structure. A weight restriction is determined based on the type of bridge and an evaluation of the extent of deterioration.

Bridges in Poor Condition by Deck Area

Square Footage of All Bridges in Poor Condition in Thousands by Fiscal Year



Source: WSDOT Bridge Office

Bridge Inventory: Changes from 2006 to 2007

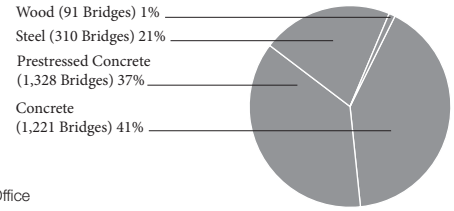
Since June 2006, the number of vehicular bridges has increased from 2,978 to 2,990. This increase is due to new bridges being built and older bridges being replaced within the highway system. WSDOT has constructed 99 vehicular bridges in excess of 20 feet in length from 2002 to 2006. This is an average of nearly 20 bridges per year. In addition, the number of bridge structures less than 20 feet long has increased from 263 to 325 since June 2006 primarily due to the inclusion of more of these structures in the inventory.

Over the past ten years, seven out of ten bridges built have been prestressed or post-tensioned concrete structures. Concrete structures represent approximately 78% of all WSDOT bridges, as compared to steel (21%) and wood (1%). The average age of all WSDOT bridges is roughly 40 years.

Type of Bridge Structure By Deck Area

Percentage of Bridge Deck Area

100% = 43,984,312 square feet of deck area for the 2,990 vehicular bridges greater than 20 feet in length.



Data Source: WSDOT Bridge Office

Bridge Preservation Program Elements

WSDOT's Bridge Preservation Program consists of the following four main program elements:

- **Inspection** – Inspect one-half of all bridges every year.
- **Replacements and Rehabilitations** – Repair bridges with deteriorated bridge elements such as concrete columns or floating bridge anchor cables. Rehabilitate mechanical and electrical operating systems on moveable bridges. Replace bridges as needed.
- **Preservation** – Extend bridge service life by repainting steel structures; also repair and overlay of concrete bridge decks.
- **Risk reduction** – Seismic retrofit of bridges and scour repair of bridge piers in rivers. This work provides a proactive approach to minimizing damage to bridges due to earthquake and higher water events.

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Bridge Inspection

WSDOT inspects nearly one-half of all traffic bridges every year and the complete inventory every two years. Bridge engineers also inspect floating bridge cables, tunnels, ferry terminal structures, and sign bridges. In addition, they provide immediate bridge inspection responses if any bridge has been damaged by a vehicle or vessel.

I-90 Mercer Slough Interchange (near Bellevue, King Co.)

In some cases, monitoring of bridges between regular inspections may be necessary to determine if continuing movement requires mitigation. One example of this is at the Mercer Slough Interchange which is located on I-90 near Bellevue just east of I-405. There are several bridges at this location. The mainline structures that carry eastbound and westbound traffic are over one-half mile in length. These structures were built over Mercer Slough, a broad, flat, peat-filled wetland.

Over the past four decades, ongoing lateral movement of the 60-foot-thick peat deposit has resulted in damaging deflections to the pile supported structures and a major waterline that runs parallel to I-90. On several occasions, emergency repairs were conducted to maintain structural integrity.

In June 2007, an automated data collection monitoring system was installed at 20 different locations along the bridges. This monitoring program provides automated data collection of the superstructure deflections, including real-time remote monitoring and automated alarms when superstructure movement exceeds pre-determined thresholds.

Automated data recorders on I-90 Mercer Slough near Bellevue (Source: WSDOT Bridge Office)

WSDOT's Sign Bridge Inspection Program

Sign bridges are structures used to support signs. They can span over a highway and have two supports or they can be a cantilever structure with one support. Over the past 12 months, WSDOT's sign bridge inspection program has become very visible throughout the state. Apart from performing in-service safety inspections of sign bridges, the program has helped traffic and construction offices across the state with pre-contract assessments of sign bridges and has also responded to vehicular collisions involving sign bridges. Structures inspected include luminaires, signal poles, strain poles, as well as cantilever, full, and bridge mounted sign bridges. In the past year, vehicular impacts have damaged 14 sign bridge structures. Inspectors determined that two were deemed acceptable to remain in service, three were repaired and kept in service, five were removed from service, and four were temporarily repaired and scheduled for replacement.

Bridge Replacements and Rehabilitations

The bridge preservation program includes funding for the replacement and rehabilitation of selected bridges. The funding to build new bridges or replace existing bridges can come from a variety of sources including the Bridge Preservation Program or the Roadway Mobility/Capacity Improvement Program. Bridge replacement projects are funded using existing Preservation funds or funds from the 2005 Transportation Partnership Account. The Bridge Replacement budget for the June 2007 - 2009 biennium includes 31 projects valued at $260.5 million with the SR 104 Hood Canal having the largest single project budget of $156 million.

Bridge Replacement Projects:

- U.S. 97 Columbia River Biggs Rapids Bridge (near Goldendale, Klickitat Co.) Project details: http://www.wsdot.wa.gov/projects/us97/biggsbridge
- U.S. 2 Ebey Island Viaduct (near Everett, Snohomish Co.) Project details: http://www.wsdot.wa.gov/Projects/US2/EbeyIslandBridgeRepair/
- SR 542 Boulder Creek Bridge (near Glacier, Whatcom, Co.) Project details: http://www.wsdot.wa.gov/Projects/SR542/BoulderCreekBridgeReplacement/
- U.S. 101 Walker Creek Bridge (near Brinnon, Jefferson Co.)
- U.S. 101 West Fork Hoquiam River Bridge at milepost 98.13 (near Humptulips, Grays Harbor Co.)

U.S. 97 Biggs Rapids Bridge near Goldendale (Source: WSDOT Bridge Office)

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SR 542 Boulder Creek Bridge near Glacier (Source: WSDOT Bridge Office)

- U.S. 101 West Fork Hoquiam River Bridge at milepost 99.49 (near Humptulips, Grays Harbor Co.)
- U.S. 101 Purdy Creek Bridge (near Shelton, Mason Co.) Project details: http://www.wsdot.wa.gov/Projects/US101/PurdyCreekBridge/
- SR 6 South Fork Chehalis River Bridge (near Adna, Lewis Co.) Project details: http://www.wsdot.wa.gov/Projects/SR6/ChehalisRiverBridge/
- SR 107 Slough Bridges (near Montesano, Grays Harbor, Co.)
- U.S. 12 Tieton River West Crossing (near Naches, Yakima Co.) Project details: http://www.wsdot.wa.gov/Projects/US12/TietonRiverBridge/default.htm
- U.S. 97 Satus Creek Bridge (near Toppenish, Yakima Co.) Project details: http://www.wsdot.wa.gov/Projects/US97/SatusCreekBridge/

Major Bridge Repairs

The major repair portion of the bridge preservation program includes corrective work that cannot be accomplished within typical maintenance programs. This work addresses a specific bridge element in need of repair and is not intended to upgrade all deficiencies to current standards. A prioritized list of major repair needs for bridges is developed each biennium. An unexpected problem may develop on a bridge that needs to be repaired as soon as possible. In this case an emergency contract would be used. Major bridge repair projects include the following:

- SR 109 Grass Creek Bridge (near Hoquiam, Grays Harbor Co.)
- I-5 Southbound Viaduct – Expansion Joints (in Seattle, King Co.) Project details: http://www.wsdot.wa.gov/Projects/I5/SpokaneStreetBridgeRepair/
- U.S. 101 Mud Bay bridges - Column Repair(near Olympia, Thurston Co.)
- SR 105 Johns River Bridge – Concrete Pier Repair (near Westport, Grays Harbor Co.)
- I-182 Columbia River Bridges – Expansion Joints (near Richland, Benton Co.)
- SR 153 Methow River Bridges - Rail Replacement (near Methow, Okanogan Co.) Project details: http://www.wsdot.wa.gov/Regions/NorthCentral/projects/SR153MethowRiverBridge/
- I-5 McAllister Creek Bridge - Column Repair (near Lacey, Thurston Co.)
- I-90 Homer M. Hadley Floating Bridge – Expansion Joints (near Mercer Island, King Co.)
- U.S. 12 Touchet River Bridge (near Touchet, Walla Walla Co.)

U.S. 101 Mudd Bay Bridges, Eld Inlet: Deteriorated concrete columns to be fitted with fiberglass jackets (Source: WSDOT Bridge Office)

Movable Bridge Repair

There are 17 movable bridges on state highways owned and operated by WSDOT. The Department also shares funding responsibility for the maintenance and operations of three additional movable span bridges with Oregon and Idaho. Twelve of these bridges are over 50 years old, and only two are under 40 years of age. A program to update the antiquated mechanical, electrical, and control operating systems of the WSDOT's movable span bridges was approved by the legislature in 1993.

Movable bridge repairs include corrective work on electrical and mechanical systems that cannot be accomplished within the typical maintenance program. A prioritized list of movable bridge repair needs is developed each biennium. There is currently one project under contract that is scheduled for construction in 2007.

U.S. 101 Simpson Avenue Hoquiam River Bridge (near Hoquiam, Grays Harbor Co.)

The planned project will rehabilitate the movable Simpson Avenue Bridge, which was built in 1928. The bridge has deteriorated mechanical and electrical systems along with cracking in the steel stringers. This project includes structural, mechanical, and electrical work.

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U.S. 101 Simpson Avenue Hoquiam River Bridge (Source: WSDOT Bridge Office)

Preservation

Preservation is a statewide goal to keep transportation facilities in sound operational condition. The objective is to achieve the best longterm financial investment for a transportation facility and prevent failure of the existing system. In keeping with this, WSDOT's bridge preservation program aims to extend bridge service life through strategies including the repainting of steel structures and the repair and overlay of bridge decks.

Steel Bridge Painting

WSDOT owns 275 existing painted steel bridges that require routine painting. There are also eight steel painted bridges that cross a river into a border state for which WSDOT shares the cost of repainting with the border state.

Protective coatings painted on steel bridge elements are essential to prevent corrosion and loss of capacity to support traffic. Steel bridges typically need to be repainted every 15 to 20 years. WSDOT schedules a bridge to be over coated with new paint when two to five percent of the existing paint has failed. Bridge painting can become a major project because of the size of the steel structures and the complexity of safety, environmental and containment system requirements. There is currently one bridge under contract, SR 433 Columbia River Lewis and Clark Bridge. Other bridge painting projects include the following:

- U.S. 101 Columbia River Astoria Bridge (near Astoria, Oregon)
- SR 433 Columbia River Lewis & Clark Bridge (near Longview, Cowlitz, Co.) Project details: http://www.wsdot.wa.gov/Projects/SR433/LewisClarkBridgePainter/
- SR 105 Johns River Bridge (near Westport, Grays Harbor Co.)
- SR 542 North Fork Nooksack River (near Glacier, Whatcom Co.)

Bridge Deck Protection

Nationally, concrete bridge deck deterioration (from corrosion of the reinforcing steel) has been the largest bridge preservation issue for years. WSDOT has been working since the early 1980's on a systematic program to prevent concrete deck deterioration by using corrosion resistant epoxy-coated rebar in new bridges and by the repair of deterioration and traffic-related wear in existing bridges with new durable protective overlays.

WSDOT inspects and performs concrete deck testing to determine which bridges require repair and overlay through a construction contract. A threshhold criteria of 2.5% deterioration has been established to determine when a bridge without an existing overlay should be programmed for a future contract. If a bridge has an existing concrete overlay then the depth of rutting is also a factor.

Statewide there are 30 bridges that have been identified for future repair and overlay. Currently, there are nine bridges under construction, and there are three bridges scheduled to begin construction in 2008. For the 2007-2009 biennium, WSDOT will spend $27.8 million to repair and overlay 12 bridges with $13.2 million coming from the 2005 Transportation Partnership Account. Bridge deck protection projects include the following:

- I-90 Spokane Viaduct (Spokane Co.) Project details: http://www.wsdot.wa.gov/projects/i90/spokaneviaductbridgedeck or http://www.downtownfreewayfix.net/
- SR 231 Spokane River (near Reardan, Lincoln Co.) Project details: http://www.wsdot.wa.gov/Projects/SR231/SpokaneRiverBridgeDeck/
- I-5 Northbound Viaduct (in Seattle, King Co.) Project details: http://www.wsdot.wa.gov/Projects/I5/SpokaneStreetBridgeRepair/
- SR 153 Methow River Bridges Deck Repair (near Methow, Okanogan Co.) Project details: http://www.wsdot.wa.gov/Regions/NorthCentral/projects/SR153MethowRiverBridge/
- I-90 Yakima River Bridge (near Cle Elum, Kittitas Co.)
- I-82 Military Road OC at milepost 11.62 (near Ellensburg, Kittitas Co.)
- U.S. 97 South of Tonasket - Bridge Deck Repair (Okanogan Co.)

Workers on the I-90 Viaduct in Spokane replace the existing latex modified concrete overlay with a fly-ash modified concrete overlay. (Source: WSDOT Bridge Office)

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Risk Reduction

Earthquakes and high-water events pose substantial risks to transportation infrastructure in Washington State. As part of its bridge preservation program, WSDOT uses seismic retrofit of bridges and scour repair to mitigate the potential risks associated with these events.

Seismic Retrofit

The purpose of the Seismic Retrofit program is to minimize and avoid catastrophic bridge failures by retrofitting bridges and structures to resist future earthquakes. The 2005 Transportation Partnership Account (TPA) provides $87 million to complete projects for 172 "High" and "Moderate" risk bridges in the Puget Sound area. This work is scheduled to begin July 1, 2007 and will be completed in 8 years. The planned 2007-09 biennium budget allocates $39.2 million for the seismic retrofit of bridges. This includes $27.2 million using TPA funds and nearly $12 million using existing Preservation funding.

Number of Bridges in the Seismic Retrofit Program

Completely Retrofitted	210
Partially Retrofitted	150
No work done to date	527
Under Contract	26
Analysis Determined Retrofit not required	8
Total	921

Data Source: WSDOT Bridge Office

The first step in seismic retofit is to perform an engineering analysis to determine if an existing bridge can resist a design level earthquake. Computer models are used to apply a force to each bridge pier, which is also referred to as a "Push-Over" analysis. The capacity of the bridge pier is then compared to the demand of the design level earthquake forces. Bridge elements with a capacity to demand ratio of less than 1.0 are reviewed and evaluated to determine the most effective method to retrofit.

Select Seismic Bridge Retrofit Projects Under Contract:

- I-5 South Seattle Vicinity Seismic Retrofits (near Seattle, King Co.)
- Southwest Region Bridge Seismic I-5 / I-205 / U.S. 12 (Lewis Co., Cowlitz Co., Clark Co.)

Seismic Bridge Projects Funded by the Transportation Partnership Account:

- I-90 Eastside Bridges mileposts 9.88 to 26.87, 19 bridges (King Co.)
- I-405 Bridges, Renton vicinity, 4 bridges (King Co.)
- I-90 and I-5 to 12th Avenue South, 3 bridges (King Co.)
- I-5 Central King to South Snohomish Bridges, 26 bridges (King Co. and Snohomish Co.)
- SR 99 Aurora Avenue George Washington Memorial Bridge (Seattle, King Co.)
- I-5 236th Street SW and 228th Street SW, 2 Bridges (King Co.)

Scour Mitigation

More bridges have collapsed from the scour of bridge foundations than from any other cause. "Scour" is defined as the eroding away of the stream bed material from under bridge foundations. Scour generally happens when a river is experiencing high water flows.

Each biennium a list of bridges requiring scour mitigation is developed. WSDOT determines the type of scour repair needed for each bridge. WSDOT coordinates with the Washington State Department of Fish and Wildlife and Department of Ecology to obtain permits to perform any in-water-work. Most repairs consist of adding rock "rip-rap" around bridge pier foundations to replace streambed material that has been removed over time.

Storms this past Winter brought significant flooding to rivers throughout western Washington. In a number of instances, the floods resulted in the need for immediate scour mitigation. The Cowlitz River flooded and washed away some of the river bank near the U.S. 12 bridge at milepost 122.76 requiring immediate scour repair. Rock rip rap was placed around bridges on SR 410 after heavy river flows washed away some of the river bank material. Scour repair efforts prior to the storms were effective in protecting bridge structures. Rip rap placed around piers on the U.S. 101 Humptulips bridge north of Aberdeen did very well resisting the flooded Humptulips River this past Winter.

Current scour mitigation projects include the following:

- U.S. 101 Humptulips River (near Humptulips, Grays Harbor Co.)
- SR 9 Pilchuck River (near Arlington, Snohomish Co.)
- SR 20 Coal Creek (near Sedro-Woolley, Skagit Co.)
- SR 9 Thunder Creek (near Sedro-Woolley, Skagit Co.)

Rip rap placed around piers on the U.S. 101 Humptulips River Bridge (Source: WSDOT Bridge Office)

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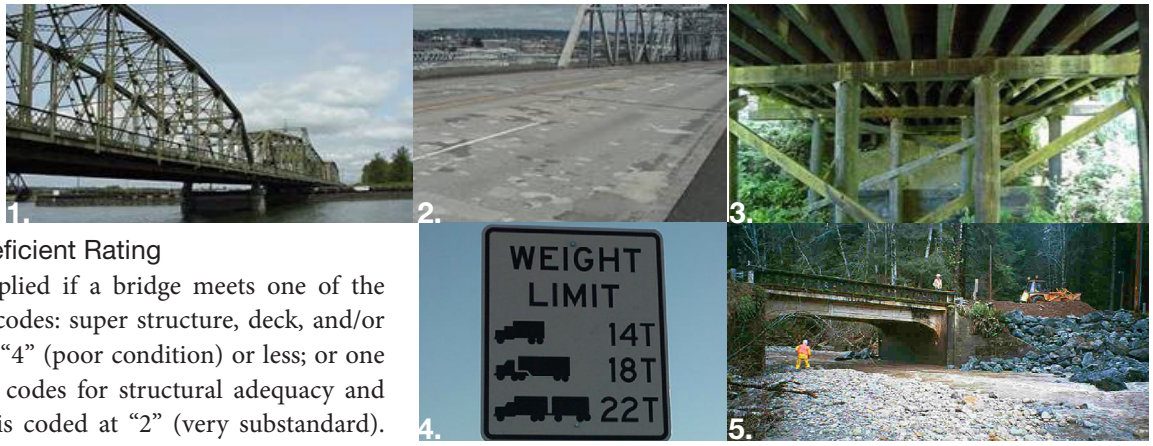
Federal Highway Administration Bridge Rating Categories

FHWA Bridge Ratings: Structurally Deficient and Functionally Obsolete

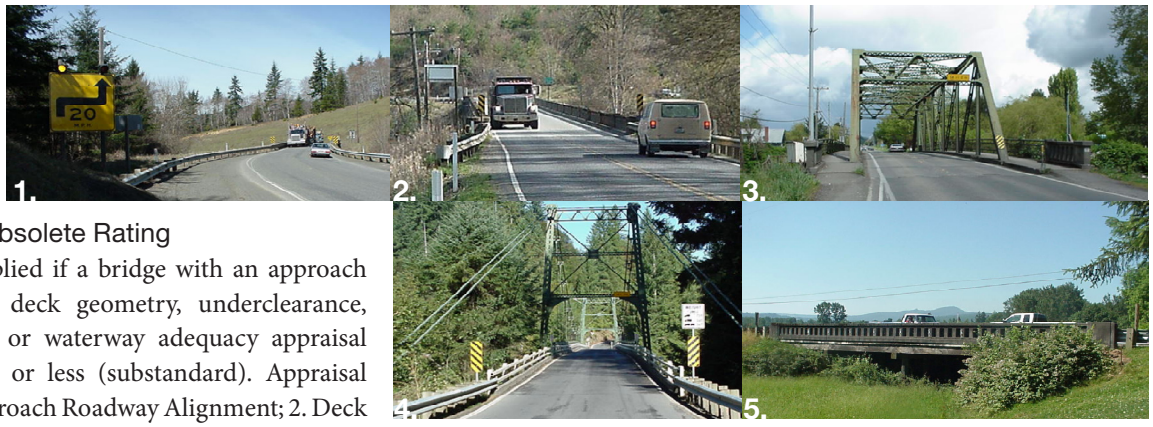
USDOT's Federal Highway Administration (FHWA) requires all state transportation agencies to report state, city, and county Structurally Deficient (SD) and Functionally Obsolete (FO) bridge ratings each year. SD and FO ratings are used to help determine federal bridge replacement and rehabilitation funding levels to the states. As of December 2006, approximately 29.5% of WSDOT bridges were classified as Structurally Deficient (SD) or Functionally Obsolete (FO) according to FHWA. This is based on a total inventory of 3,083 structures. However, only 107 (3.4%) of WSDOT bridges were classified by FHWA as SD, while 805 (26.1%) of WSDOT bridges were classified as FO.

The SD rating refers to bridge superstructure, deck, substructure, structural adequacy, and waterway adequacy. The FO rating refers to approach roadway alignment, deck geometry, under-clearances, structural adequacy, and waterway adequacy. The WSDOT Bridge Program prioritizes SD bridges with public safety concerns before addressing FO bridges that require solutions such as wider lane widths or higher vertical clearances. Aside from tracking SD and FO, WSDOT's Bridge Program emphasizes the importance of cost effective preservation programs, such as bridge replacement and rehabilitation, seismic retrofit, bridge painting, bridge deck rehabilitation, and bridge foundation scour mitigation.



The Structurally Deficient Rating

The SD rating is applied if a bridge meets one of the following condition codes: super structure, deck, and/or substructure rates at "4" (poor condition) or less; or one of the two appraisal codes for structural adequacy and waterway adequacy is coded at "2" (very substandard). Condition categories are: 1. Superstructure; 2. Deck; 3. Substructure; 4. Structural Adequacy (appraisal category); and 5. Waterway Adequacy (appraisal category).



The Functionally Obsolete Rating

The FO rating is applied if a bridge with an approach roadway alignment, deck geometry, underclearance, structural adequacy, or waterway adequacy appraisal code is rated at "3" or less (substandard). Appraisal Categories are: 1. Approach Roadway Alignment; 2. Deck Geometry; 3. Underclearances; 4. Structural Adequacy; and 5. Waterway Adequacy.