Background Brief on …

# Bridges

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Approximately 6,800 bridges connect Oregon's 59,000 mile road and highway system. The road system is vital to the movement of citizens, visitors and freight. Bridges are points where the road system is especially susceptible to interruption. When officials must limit the weight of loads allowed on bridges that may not have been built to handle today's traffic and loads or are beginning to show signs of deterioration, commerce can be seriously disrupted by requiring long detours for heavy trucks on alternate routes. Freight bottlenecks are also caused when bridges lack sufficient vertical or horizontal clearances.

The Oregon Department of Transportation **(ODOT)** owns and maintains nearly 2,700 bridges. Most of the rest are under the control of local governments throughout the state. ODOT inspects most bridges every two years; those that are beginning to show signs of significant wear are inspected more frequently. Funding for bridge inspection, maintenance, repair, and replacement is part of existing highway funding mechanisms. Bridge maintenance and minor repairs fall to ODOT maintenance crews and are covered in the maintenance portion of ODOT's budget. Bridge structural repair or replacement is part of the Bridge Program in the Statewide Transportation Improvement Program (**STIP**).

### Aging Bridges

Most of Oregon's bridges are nearing the end of their "design life." Over time, in each successive construction era, bridge design life has increased. From 30 years in the 1930s to 50 years in the 1950s to 100 years or even 150 years with contemporary construction. The life of a bridge, though long, is not infinite. No series of continued repairs regardless of how well timed, can continue to extend the life of a bridge forever. Eventually, all bridges will need to be replaced. The service life of a bridge is an estimate of the number of years a bridge may remain in service. The expected service life can vary depending on the quality of the construction materials and methods; the quality and

timing of maintenance activities; environmental factors; and usage. Although the range is wide (30 to 100 years or more), the American Association of State Highway and Transportation Officials' default value of 75 years reflects a useful average for the era and type of structures currently in the ODOT inventory.

In 2010, the median age of ODOT bridges is 45 years and the most frequently occurring bridge age is 52. Approximately 12 percent of the ODOT inventory is currently 70 years or older. The passage of time, traffic, effects of the elements, and the structural weight of the bridges themselves have taken their toll on older bridges that were designed for lower vehicle weights, slower traffic speeds, and less traffic volume than are typical on Oregon's roads today.

Modern trucks are heavier than those in use when many of the state's bridges were designed and built. The number of miles traveled annually by trucks exceeding 70,000 pounds has increased from roughly 100,000 in 1965 to over 1.5 million today. In some cases, the trucks exceed what older bridges were designed to carry.

Enforcement of an 80,000 pound weight limit on a significant number of Oregon's bridges would impose a number of costs on motor carriers, including the need to purchase additional trucks, hire additional drivers, and pay higher weight-mile taxes. Those costs, when passed on to producers, would also have a negative effect on many business sectors, particularly manufacturing.

## The Oregon Transportation Investment Act (OTIA)

A number of reinforced concrete deck girder bridges built between 1947 and 1961 have had significant cracking problems. In 2002, the magnitude of the problem led to weight limits on affected bridges until repairs could be made, including 27 bridges on major state routes.

The ODOT Bridge Strategy Task Force was formed to analyze the cracking problems and released its final report on June 20, 2002. In that report, the Task Force recommended repair efforts focus on returning the state's two main corridors, Interstate 5 and Interstate 84, to full freight service by repairing all load-limited bridges. Subsequent repairs were also to be undertaken following this "corridor-based" strategy.

In 2003, the Legislative Assembly passed House Bill 2041, referred to as OTIA III, authorizing ODOT to issue additional revenue bonds for highway improvement projects, including bridge repair and modernization. The measure increased vehicle registration and title transaction fees to help repay the bonds. The amount dedicated to bridge projects was divided between state bridges ($1.3 billion) and city and county bridges ($300 million). Projects were selected by the Oregon Transportation Commission with input from technical rating committees, the Oregon Freight Advisory Committee, Area Commissions on Transportation, and stakeholders.

A 2004 study by Oregon State University **(OSU)**, commissioned by ODOT, found that bridges could remain in operation while awaiting repairs or replacement. The study allowed ODOT to re-evaluate the cracked bridges and modify the planned action in many cases.

The OTIA III State Bridge Program included replacement or repair of 365 ODOT bridges, making it the largest bridge construction effort in Oregon since the Interstate Highway era. As of March 2010, 32 are in the design phase, 76 are under construction, and 224 are open to traffic. As a result of the OSU study and further analysis, 93 state bridge projects originally slated for work in the OTIA III program have been determined to need no immediate repair work.

By its completion in 2013, the OTIA III State Bridge Program will have replaced 150 bridges, resulting in the lowest forecast levels of overall bridge deficiency in Oregon in nearly two

decades. OTIA III has not, however, overcome the anticipated rate of deterioration. As OTIA III projects are completed, more aging bridges will fall into the categories of needing repair or replacement.

## Design-Build vs. Design-Bid-Build

*Design-bid-build* contracting has historically been used for most public works projects, separating the delivery process into three distinct phases. During the design phase, ODOT or a private sector contractor produces the engineering design; in the bid phase, ODOT assembles the documentation, advertises the bid, and awards a construction contract; in the build phase, a private contractor builds the project with ODOT oversight.

With the passage of OTIA III, ODOT sought to increase its usage of the *design-build* method of contracting. In this process, a bid is put out for both design and delivery of a project. Bids can be submitted by a single entity, a consortium, a joint venture, or other organization assembled for a particular project. Design-build contracting has become widely used throughout the United States during the past 15 years and can reduce delivery time and related delays, simplify relationships, more quickly develop solutions and establish project costs, and decrease the number of construction contract changes.

Customary practice with design-build contracting is to rely on best value, which takes into account both the technical capabilities and qualifications of the design-build team and the cost of the bid. There is no universally accepted approach for determining best value and the request for proposals usually specifies the relationship between cost and technical factors.

## Context Sensitive and Sustainable Solutions

As part of ODOT's bridge delivery program under OTIA III, the agency has adopted a framework known as Context Sensitive and Sustainable Solutions, or $CS^3$. The framework is organized around five core principles for bridge program projects:

- Stimulate Oregon's economy
- Employ efficient and cost-effective delivery practices
- Maintain freight mobility and keep it moving
- Build projects sensitive to their communities and landscapes
- Capitalize on funding opportunities

$CS^3$ is designed to preserve Oregon's scenic, aesthetic, historical, cultural and economic and environmental values while building safe and enduring projects.

## Historic and Coastal Bridges

Many of Oregon's bridges are especially valuable because of their historical significance; hence, they require additional maintenance. Because of their locations, many of these bridges also experience greater wear from environmental conditions. In order to fully restore and preserve the state's historic bridges, 11 require major painting, three require cathodic protection, and three are moveable bridges that require restoration.

## Local Bridges

ODOT is responsible for all bridges on state highway. However, state highways make up only 8,000 miles of Oregon's road system, compared to 33,000 miles of county roads and 10,800 miles of city streets. There are 4,000 bridges on county roads and city streets and those bridges must also be inspected, maintained, and periodically replaced. ODOT administers contracts for the inspection of local agency bridges with funding from the local bridge program. Nearly 20 percent of county bridges are either structurally deficient or functionally obsolete.

The OTIA III Local Bridge Program provided $300 million to repair and replace county and city bridges. Those projects have been completed.

## Columbia River Crossing

The Columbia River Crossing is a bridge, highway, and transit project that is meant to address transportation challenges on the Interstate 5 Bridge **(I-5)** between Oregon and

Washington and its approaches in Portland and Vancouver. With only three lanes in each direction, the existing bridges are strained to capacity to carry the current 135,000 vehicles each weekday. With the population of the region expected to increase by over one million people during the next 25 years and freight truck traffic expected to more than double during that same period, transportation planners are seeking solutions for congestion, safety, bicycle and pedestrian access, public transportation needs, seismic vulnerability, and marine navigation and mobility constraints.

Oregon and Washington created a 39-member Columbia River Crossing Task Force to represent a broad range of perspectives to advise the project team. That group selected a 12-lane replacement bridge that incorporates light rail and dedicated bicycle/pedestrian access. A second entity, the 10-member Project Sponsors Council, made the decision to reduce the size of the proposed bridge to 10 lanes (three through lanes and two interchange connections in each direction) and reduced the scope of interchange modifications, reducing the project's estimated cost to between $2.6 and $3.6 billion. The bridge is to be funded by a combination of federal funds, state funds and tolling revenues.

Governors Kulongoski and Gregoire convened an Independent Review Panel in February 2010 to assess the financial and implementation plans for the project. The current timeline has construction beginning as early as 2012, with completion scheduled for 2018.

## Seismic Risk

Oregon lies in a region of particularly high seismic activity, due primarily to its proximity to the "Cascadia Subduction Zone" **(CSZ)**, where the Juan de Fuca (tectonic) Plate pushes under the North American Plate. The seismic activity below Western Oregon is capable of generating earthquakes of magnitudes as high as nine on the Richter scale, sufficient to cause catastrophic damage to structures, including bridges. A recent ODOT and OSU study, "Seismic Vulnerability of Oregon State Highway Bridges" (November 2009), concludes that a large CSZ earthquake off the Oregon Coast would result in major widespread damage that would prevent vehicular travel on many segments of I-5, U.S. 101 and all routes between I-5 and the coast.

Prior to 1958, bridge designs did not account for "seismic loading," due to the lack of understanding at that time of the earthquake potential in the Northwest. More sophisticated analysis in the years following the 1989 Loma Prieta earthquake in California has alerted ODOT engineers to the potential for bridge failures during an earthquake, as well as methods for retrofitting most of those bridges to enhance their ability to survive such an event.

ODOT has identified retrofit methods that can help protect bridges from earthquake damage; Phase I "life safety" retrofits strengthen the connection of the bridge superstructure to the substructure, while Phase 2 "serviceability" retrofits strengthen the piers and footings of the bridge. Even with retrofits, however, engineers note that it is impossible to absolutely assure no damage from a high-magnitude earthquake. Routes have been prioritized according to their importance during an emergency situation.

The Seismic Vulnerability report outlined bridge vulnerability to seismic events in Oregon based on six earthquake scenarios. The report estimates which bridges would remain serviceable after an earthquake, which would be damaged, and which would be likely to collapse, based on design, age and proximity to the earthquake in the model. Based on the number of bridges requiring seismic retrofits and the funding available to perform those retrofits, the report estimated that retrofit and replacement of all vulnerable bridges would take approximately 219 years at the current rate of five bridges per year. The time period would be significantly longer, however, due to the amount of Bridge Program devoted to debt service for the OTIA III State Bridge Program.

In regard to seismic retrofits, ODOT spends about $1 million annually when retrofit is included as part of other scheduled work on bridges. No strategic, stand alone retrofitting is being done in the STIP Bridge Program. The agency has partially (phase 1) retrofitted 178

bridges as of 2009, and replaced 296 others with new seismic designs.

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