

Bridges Beyond 100 Years: Innovative Systems

New bridge design approach can add years to service life

Bridge replacement is a major source of disruption to the nation's transportation system, so bridge owners need ways to design bridges that last longer. Current bridge design practices consider the "ultimate limit behavior state" that prevents collapse. However, most bridge rehabilitation and reconstruction projects result from deterioration such as cracks, corrosion, and deformation. Knowledge of these "service limit states" is limited and largely based only on qualitative data and experience. Quantitative data from the element distress areas of bridges are needed to inform service-based design.

Guidance for Service Limit State Design

The Solution

Developed through the second Strategic Highway Research Program (SHRP2), the **Service Limit State Design for Bridges** toolkit offers a **quantitative framework in which to assess service limit states more accurately. The toolkit provides actual performance data, component-based distress models, and specific guidance for common bridge elements.** Information includes:

- Framework for calibrating service limit state specifications
- Service limit state load and resistance factors
- Bridge design procedures and model specifications for service limit states
- Tools required for future service limit state improvements
- Model specification changes that include designing for durability

The toolkit allows for future improvements in service limit state calibration, particularly as data become available from projects that are currently under way (such as the Long-Term Bridge Performance Program). The **toolkit contains databases, software tools used in the calibration (such as Monte Carlo spreadsheets), instructions for developing new or revised spreadsheets, deterioration models, and a user's manual.**

The framework will calibrate the following AASHTO service limit state design elements:

- Live load deflections
- Bearing movements

Toolkit will enable enhanced bridge design guidance

FOCUS AREA: Renewal (R19B)

Toolkit includes a quantitative framework to assess service limit states, bridge design procedures and model specifications, tools for future service limit state improvements, and model specification changes to support designing for durability.

Save Lives

- Enhanced bridge designs based on quantitative deterioration models will reduce the frequency of construction work zones associated with bridge preservation, rehabilitation, and reconstruction activities.

Save Money

- Extending the service life of bridges will save money by reducing the frequency of rehabilitating and replacing these very costly elements of the transportation system.

- Settlement of foundations and retaining structures
- Permanent deformations of compact steel components
- Fatigue of structural steel and the steel reinforcement in concrete (complementary research being conducted through National Cooperative Highway Research Program [NCHRP] 12-83)
- Slip-critical bolted connections
- Concrete approaches

The Benefits

By improving service limit state design, **the service life of bridge components can be increased** and designers can **select bridge components based on expected maintenance and difficulty of replacement**. The toolkit and framework establish a protocol by which future research and data collection fit easily into the approach to service limit state design. This approach will optimize future efforts by avoiding the collection of incomplete and inaccurate data on service limit state behavior.

Who is using these tools?

California and Federal Lands Highway are currently using Service Limit State Design for Bridges through the Implementation Assistance Program (IAP). They received User Incentive awards through Round 7 of the IAP.

How can you learn more?

For more information, contact Silas Nichols at FHWA, silas.nichols@dot.gov, or Patricia Bush at AASHTO, pbush@aaashto.org. Updates on current implementation efforts can be found at the AASHTO product webpage at http://shrp2.transportation.org/Pages/R19B_ServiceLimitStateDesignforBridges.aspx or at www.fhwa.dot.gov/GoSHRP2.

About SHRP2 Implementation



The second Strategic Highway Research Program is a national partnership of key transportation organizations: the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the Transportation Research Board. Together, these partners conduct research and deploy products that will help the transportation community enhance the productivity, boost the efficiency, increase the safety, and improve the reliability of the Nation's highway system.

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