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Washington State Department of Transportation

JANUARY 2016

Bridge Innovation

Here are ten stories about WSDOT's innovative bridge work. From steel that bends and remembers its original shape . . . to prefabricating huge parts off site, WSDOT Bridge and Structures engineers introduce new methods.

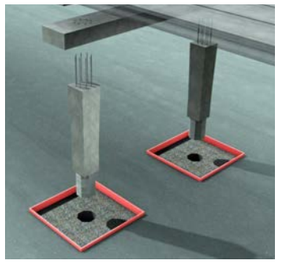
SHAPE MEMORY ALLOYS

Rebar Springs Back! Concrete bends!

Shape Memory Alloy (SMA) and Engineered Cementitious Composite (ECC) innovations are used in bridge design to improve seismic resilience, and serviceability of a bridge after an earthquake. SMA is a type of metal that's manufactured from either a combination of nickel and titanium, or copper, magnesium and aluminum. The metal is shaped into round 'rebars' and cast with the concrete. During an earthquake SMA bends but returns to its original shape (just like some new types of eyeglass frames). ECC is an added ingredient to concrete. We add polyvinyl alcohol fiber to stop cracking when columns are bent during an earthquake. This means we can significantly reduce damage and keep bridges open to traffic. WSDOT has a SMA-ECC project at the SR 99 Alaskan Way Viaduct Approach.

ACCELERATED BRIDGE CONSTRUCTION

A Kit of Parts



The Federal Highway Administration (FHWA) has been actively promoting the advantages of Accelerated Bridge Construction (ABC). Reductions in traffic delays and hazards provide infrastructure improvements at a fast past, yielding benefits to the traveling public and the regional economy. ABC increases costs by 30-100% so we rigorously evaluates projects. Project and Traffic Impact Assessments, ABC Impact Quantification Proposals, ABC Cost Benefit Developments, ABC Selection Criteria and Schedule are tools for the innovative practice.

LONG SPAN PRESTRESSED GIRDERS

A Huge Part for the Kit!

This is the biggest bridge part ever! They're over 200 ft. long and weigh a quarter of a million pounds each. That's the second longest single girders delivered by road in North America. WSDOT, Georgetown University researchers and the Precast Concrete Institute designed special high strength concrete for the super long spans of the SR 99 Alaskan Way Viaduct approaches.

LIGHT WEIGHT CONCRETE

Bridge Girders Save Weight!

The 270 foot two span bridge crosses the Puyallup River on SR 162 just south of Sumner Washington. By using special light weight aggregate rocks, engineers are able to decrease concrete weight from 150 lbs. per cubic foot to a bit over 100 lbs. That reduces shipping costs. It reduces foundation costs. And it even reduces the forces imparted to the bridge during an earthquake.

CURVED PRESTRESSED GIRDERS

The Newest Part in the Kit!

The Satus Creek Bridge represents a new innovation in bridge design. It is a horizontally curved prefabricated concrete bridge. WSDOT worked closely with the Pacific Northwest Precast Concrete Institute to develop the new technology. The design of the curved girders was analyzed by our engineers with PGSuper computer software: a powerful computer program developed by WSDOT bridge engineers. Then the 2.5 million dollar bridge was assembled on site with the newest addition in our kit of parts. Bridge architects colored and textured the concrete to blend with native grasses, sage brush and basalt.

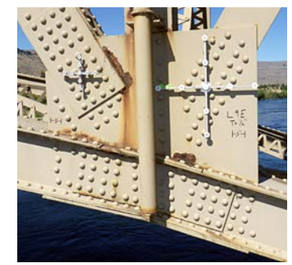
GEORGE SELLAR BRIDGE

Repair vs Replace a Classic

The American Society of Civil Engineers awarded this the most beautiful bridge with 400 ft. spans in 1950. Later it was named after Senator George Sellar. So bridge engineers were eager to save the bridge when it needed to be widened for extra lanes and sidewalks. The 12 million dollar revitalization saved over 30 million dollars compared to replacement.

TRIAGE EVALUATION PROCEDURE

Right on target! $2 million saved in bridge loading rating analysis.



In 2007 a major collapse in the Midwest prompted the FHWA to require WSDOT analyze 110 bridges immediately. After months of research, WSDOT and the UW came up with a methodology called Triage Evaluation Procedure. By rapidly field collecting data with special magnetic targets, bridge engineers identify only a bridges weak link. The method saved upward of 2 million dollars.

Science geeks can read on line about the mathematics engineers used at https://en.wikipedia.org/wiki/Von_Mises_yield_criterion

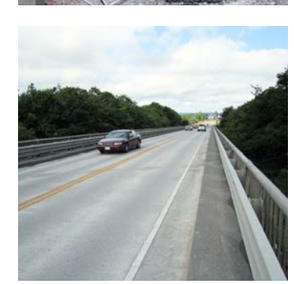
REDUCING PAINT DRYING TIME

Steel Painting

In 2015 we used Termarust Paint on our first full bridge painting. The I-5 Skookumchuck River Bridge in Centralia used a 'wet-on-wet' application to reduce drying time. Plus the paint remains flexible during its entire service life. You can see by the photo, it takes a lot to keep the environment clean when we paint bridges.

BRIDGE REHABILITATION

Modified Concrete Overlays



We're among the first in the United States to use bridge Hydro-Milling. We remove deteriorated driving surfaces with high pressure water: all the way to the steel rebar. Then we use modified concrete to replace the surface. These 'overlay's are much less expensive than a complete replacement. We've repaired 165 bridges that have lasted more than 25 years.

A BRIDGE STAYS OPEN DURING REPAIR

Bridge Bottom Soffit

We replaced a box girder bottom slab without closing the bridge. Bridge 5/537S is a heavily traveled structure that carries traffic from West Seattle to northbound Interstate-5. In recent years WSDOT bridge inspectors had identified poor quality concrete. The condition of the concrete was so poor in places that it could be easily removed with hand tools. WSDOT developed plans to replace the bottom slab while maintaining traffic on the bridge.