Wisconsin

Leveraging data and technology to put more local bridge projects into production

by Aaron Bonk, Wisconsin Department of Transportation Bureau of Structures

Thinking about locally owned bridges in Wisconsin can conjure up a variety of images, from small timber bridges blending in with the countryside or older stone arches spanning small creeks to concrete T-beam bridges, and any number of other structure types in an array of settings. While all these structures are unique in some way, they can also have much in common.

Over the past several years, the Wisconsin Department of Transportation (WisDOT) Bureau of Structures (BOS) has focused on the similarities among smaller structures to develop a Standard Bridge Design Tool (SBDT). After successful pilot testing, the SBDT is now being widely used. Its implementation comes at arguably the perfect time given the historic funding opportunities of the Bipartisan Infrastructure Law.

The SBDT provides a catalog of solutions for single-span, cast-in-place concrete slab bridges, which are found throughout the local program and are the types most used for replacements. Designers and planners can download these standard plans to streamline the work, allowing the local program in turn to preserve resources to maximize overall output.

Having such a tool has been an ongoing consideration at WisDOT, and it became a greater priority as the Bipartisan Infrastructure Law navigated the federal legislative process. Anticipating this opportunity, WisDOT management asked engineering staff to explore options to help maximize investment in local bridges. The focus made sense, considering there are almost 9000 such bridges statewide, making up roughly 63% of the total bridge inventory. In addition, local bridges are more likely to carry load postings and poor condition ratings compared with their counterparts in the state system (**Table 1**).

As an organization, WisDOT has shifted to a more data-driven, condition-based asset management philosophy over the last decade. This shift helped set the stage for SBDT development. The WisDOT BOS has long been a supporter of making the right maintenance and replacement choices at the right time. This approach has historically included recommending proper cycles of routine maintenance; completing bridge rehabilitations as close as possible to the time when they are needed, with the understanding that other work in the project vicinity may shift timelines slightly; optimizing material choices given project-specific criteria; and making the appropriate structure-type selection when replacement is necessary based not only on up-front construction costs but also the associated life-cycle maintenance costs. Each of these decisions can extend the life of the structures and effective stewardship of taxpayer dollars. For more on WisDOT's asset management philosophy and the development of our process, see the Concrete Bridge Stewardship article on page 28 of this issue of *ASPIRE*®.

With Bipartisan Infrastructure Law funds in place and WisDOT ready to funnel significant

In Racine County, the 58th Road Bridge over the west branch of Root River Canal served as a pilot project for implementation of the Wisconsin Department of Transportation's Standard Bridge Design Tool. All Figures and Photos: Wisconsin Department of Transportation.

Table 1. Comparison of load-posted bridges in the Wisconsin local and state inventories			
	Total bridges	Load-posted bridges	Percentage of bridges with postings
Local System	8957	460	5.1%
State System	5363	16	0.3%

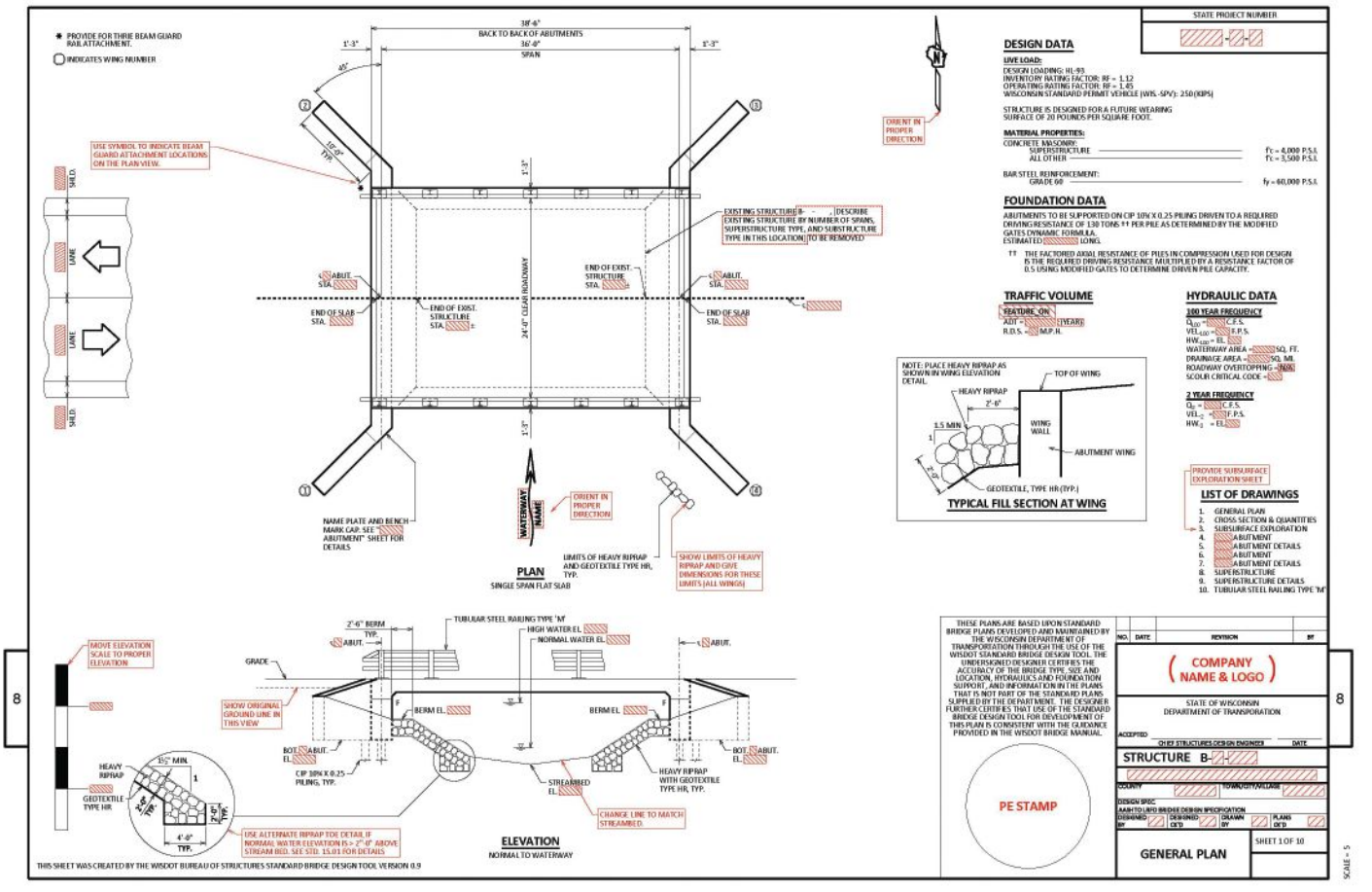
funding to the local system, BOS recommended developing standardized bridge plans for use on locally owned bridges. Concrete bridges, in one form or another, make up approximately 70% of the Wisconsin bridge inventory. In most situations, concrete is the structural material of choice for Wisconsin bridges because it is durable and can resist deterioration due to deicing agents, which are used throughout the winter months. When reviewing local bridge-replacement projects completed in the last two decades, BOS found that cast-in-place concrete slab bridges were the most common structure type selected, used in almost 50% of cases. Given the data, standardizing the design of one of the state's bread-and-butter bridge types—single-span concrete slab bridges—made all the sense in the world.

WisDOT BOS strategically set out to create a tool that would not only produce standard bridge plan sets, but also be able to dynamically change with shifts in design codes, design policy adjustments, and drafting standards. Approximately 20 years ago, WisDOT had a catalog of standard bridge plans, but they quickly became obsolete as the process of updating each individual plan set whenever something changed was incredibly resource intensive. The current version of standard bridge plans that WisDOT developed uses C# coding and the AutoCAD ObjectARX programming environment to connect the design model to Civil 3D, which creates the plans. The coding effectively allows WisDOT to adjust one set of inputs that can be applied across different bridge configuration parameters, as opposed to editing all options individually.

Once the strategic vision for the coding and programming of the SBDT was set, BOS next determined how the designers would interface with the tool to receive the designs and plans and efficiently work with them. The SBDT program uses WisDOT BOS proprietary slab span design and rating software and WisDOT standard details to create the standardized bridge plans. These plans come in the form of PDF and Civil 3D files, which are downloaded by the designer from the BOS website and the program's user interface. To obtain the appropriate standardized design and plans from the website, the project designer completes the preliminary structure design by first defining the type, size, and location of the bridge and then determining seven input parameters (span length, bridge clear width, skew, railing/parapet type, minimum abutment height, paving notch, piling type). The SBDT programming was set up to efficiently create over 12,000 combinations of bridge designs and plans from the input parameters to fit a wide array of local program bridge site constraints. For further information about the SBDT parameters and an example of the standard plans, visit https://wisconsindot.gov/Pages/doing-bus/local-gov/lpm/lp-standarized-bridge-plan-pilot.aspx.

As a part of the SBDT development, WisDOT needed to address the legal aspect of shared liability for completion of the final bid documents and plans. Attorneys for WisDOT

Standardized plans that are provided to the designer from the tool's website user interface. The red boxes indicate items that the designer must update



developed an agreement form that all consultant engineering firms must sign to be eligible to take on the design work for projects involving the tool. The agreement states that WisDOT takes on the liability for the accurate design, analysis, ratings, and plan assembly, while the consultant firm that stamps the final plans takes on the liability for the proper sizing of the bridge, use of the tool, and updating the plan items requiring modification when received from the tool's website.

WisDOT BOS's development of the SBDT started in 2020 and was finalized for pilot-project use in 2021. Ten pilot projects representing the five regions of Wisconsin were identified, with construction slated for 2022 and 2023. As of publication of this article, all the pilot projects were designed, bid, let, and constructed with no significant issues identified within the process, designs, or plans. For these 10 pilot projects, savings of approximately 33% of average historical costs were seen in the design phase. Moving forward, WisDOT BOS has identified an additional 134 candidates for bridge-replacement projects scheduled for construction between 2023 and 2027 that fit the parameters of the SBDT. It is anticipated that the cost savings in the design phase for these projects will be close to 67% of typical projects because designers will become more familiar with the tool. All savings in the design phase will help WisDOT invest more money in the local program and replace additional bridges.

Single-span cast-in-place concrete slab bridges were designed and constructed throughout Wisconsin using standardized plans under a new pilot program. The inset map shows the locations of the 10 pilot projects, which were spread across the five regions of the state.

Wisconsin has always sought to allocate program resources efficiently, and the creation of a standardized bridge program for single-span, cast-in-place concrete slab bridges is another way of accomplishing this objective. WisDOT is already seeing the benefits of this structure type on the local system as well as the benefits of having a consistent delivery process for the design of these structures.

For more information about Wisconsin's bridges, visit https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/default.aspx.

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Part of the website user interface showing inputs required by the designer to receive standard bridge plans output.