Using Bridge Life-Cycle Cost Analysis Tools for MAP-21

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This article is a follow-up to the article titled "Map-21 and Bridge Life-Cycle Cost Analysis" published in the Summer 2013 issue of *ASPIRE*.™ This article describes the project-level, life-cycle cost analysis using the Federal Highway Administration (FHWA) bridge life-cycle cost analysis (BLCCA) software tool. An example illustrates application of the tool to compare the life-cycle costs for rehabilitation versus replacement of a bridge. The FHWA BLCCA software tool is a powerful tool for performing various levels of project cost analysis and comparative studies. It is ideal in support of making project level strategic investment decisions.

FHWA BLCCA Software Tool

Bridge project engineers consider various investment strategies on a project level. The strategies primarily include:

- investing in the repair of existing bridge deterioration,
- preservation activities that extend service life and delay major investments, or
- replacing a bridge that has advanced deterioration.

For this purpose, FHWA offers the BLCCA software tool. This tool helps engineers perform an analysis of each strategy for a specific bridge so that, in comparison, the strategy that provides the desired performance with the best potential life-cycle cost scenario can be selected. Specifically, the BLCCA software calculates the present value of costs of alternative investment strategies applied over a specific time horizon.

The BLCCA software tool is based in Microsoft Excel. It includes worksheets organized into four separate areas: summary, data, settings, and reports and models.

Each group of worksheets provides specific details about the analysis. For example, the summary worksheet provides a synopsis of the analysis results and hyperlinks to relevant worksheets. The worksheets in the data area display details about elements and costs for alternative strategies.

To run the software, the analyst simply opens the file and selects the data set to link to, selects the bridge of interest from the list of bridges, and begins inputting the specifics about each alternative. It allows users to select data about a specific bridge along with its in-service condition ratings from either the National Bridge Inventory (NBI) or Pontis data set.

Specific life-cycle actions such as rehabilitation, deck repairs, or replacement can be selected for alternative strategies that the user identifies. Using these inputs, the software applies deterioration algorithms to each element associated with the bridge and displays a summary of the performance of each investment strategy over the user-specified time horizon. The element deterioration algorithms and costs were refined from data collected on bridges nationwide and provide recommendations of bridge performance for use by the analyst. Each attribute can be overridden or customized by the analyst by simply entering values in pertinent fields. In the absence of expert knowledge, the recommendations provide a good gauge. The user can revisit other specific aspects of the analysis and refine inputs such as costs, dates that actions occur, or add additional actions as necessary.

Copies of the BLCCA software will be available for download from FHWA by request beginning in October 2013. It is placed on the local machine along with the specific (NBI) data set. FHWA provides access to NBI data sets on its webpage at http://www.fhwa.dot.gov/bridge/nbi/ascii.cfm.

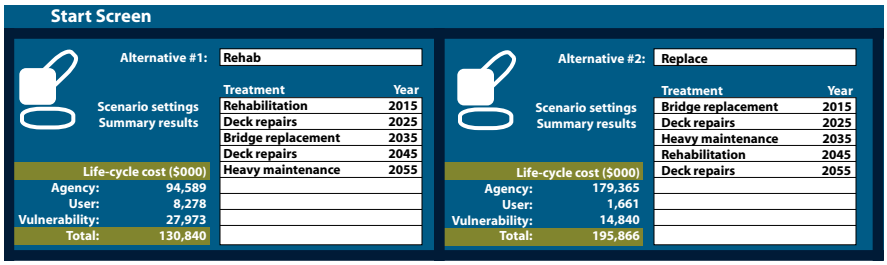

Figure 1: An example comparing the life-cycle costs for rehabilitation versus replacement of a bridge using the Federal Highway Administration bridge life-cycle cost analysis (BLCCA) software tool. Diagram: FHWA.

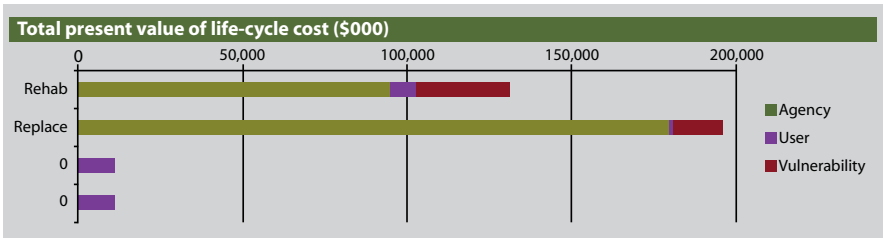

Figure 2: The outcome from an example comparing the life-cycle costs for rehabilitation versus replacement of a bridge using the Federal Highway Administration bridge life-cycle cost analysis (BLCCA) software tool. Diagram: FHWA.

Illustrative Example

An example analysis using the software to compare the life-cycle costs for performing rehabilitation versus replacing a bridge is depicted in **Figure 1**, which shows the scenario for each strategy.

The software estimates the agency costs for each of these activities needed to restore each affected element to acceptable performance levels. Specifically, it maps the selected actions (for example, heavy maintenance) to element level activities to calculate costs.

The user can define the particular aspects of the new bridge by selecting relevant elements of the new bridge such as steel beams or prestressed concrete girders.

The outcome of the analysis is depicted in **Figure 2**. The bar graph displays the present value of the total costs for the two alternatives. Costs are color delineated by direct agency costs for materials or construction, user costs, and vulnerability costs.

Basically the results show that the net present value of alternative 1, the rehabilitation strategy, is $130.8 million versus $195.9 for alternative 2. Initial cost of replacement is $166 million (versus $21 million for rehab), but the increased cost is partially offset by reduced user costs from widening, reduced costs associated with seismic vulnerability, and reduced agency maintenance costs. Risk features of the software could also be used to explore various uncertainties of input variables such as quantities of materials or dates when actions occur.

Closing Remarks

Many life-cycle cost analysis tools are available to help bridge engineers focus on the long-term impact of their decisions. The FHWA BLCCA software tool, based on NCHRP Project 12-43, is a powerful tool for performing various levels of cost analysis and comparative studies. Its strengths are the elemental deterioration algorithms, costs associated with restoring required performance from the level of deterioration, and its risk features. A comparison of various types of tools is available on FHWA's webpage at http://www.fhwa.dot.gov/publications/publicroads/05nov/09.cfm.

The Federal Highway Administration offers a Bridge Investment 101 workshop that discusses software tools, and other resources for analyzing bridge investments. Please visit FHWA's economic resources internet webpage at http://www.fhwa.dot.gov/infrastructure/asstmgmt/invest.cfm or contact Nat Coley at 202-366-2171 or ncoley@dot.gov for additional information.

EDITOR'S NOTE

More information on Myint Lwin, including a presentation titled "Concrete in my Life," is available at www.aspirebridge.org. Click ond open "Resources."

Lwin to Retire after 40 years

Myint Lwin has announced that he will retire from the Federal Highway Administration (FHWA) at the end of September. Since the beginning of *ASPIRE*™ in 2007, Myint has contributed 27 articles about the ongoing activities of the FHWA. For this, we thank him.

As Director, Office of Bridge Technology and State Bridge Engineer for Washington State, Myint has always worked closely with the concrete bridge industry to assure safe, efficient, sustainable, and economical bridges. He has always been receptive to new ideas and new ways to cooperate with industry. His attendance at every bridge conference was almost a certainty.

On behalf of the concrete bridge industry, we wish Myint good health, happiness, and success in his retirement.