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Bridge Life-Cycle Cost Analysis

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SUBJECT AREAS
Bridges, Other Structures, and Hydraulics and Hydrology

Research Sponsored by the American Association of State Highway and Transportation Officials
in Cooperation with the Federal Highway Administration

TRANSPORTATION RESEARCH BOARD
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Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Academies was requested by the Association to administer the research program because of the Board’s recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

Note: The Transportation Research Board of the National Academies, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers’ names appear herein solely because they are considered essential to the object of this report.
The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chair and vice chair, respectively, of the National Research Council.

The Transportation Research Board is a division of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board’s mission is to promote innovation and progress in transportation by stimulating and conducting research, facilitating the dissemination of information, and encouraging the implementation of research results. The Board’s varied activities annually engage more than 4,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. www.TRB.org

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The research reported herein was performed under NCHRP Project 12-43 by the National Engineering Technology Corporation (NET Corp.) and Delcan Corporation. NET Corp. was the contractor for this study and for the software development.

Hugh R. Hawk, Chief Bridge Engineer, Delcan Corporation, was the principal investigator. The other authors of this report are Dr. Andy Lemer of the Matrix Group and Dr. Kumares Sinha, Professor of Civil Engineering, Purdue University. The bulk of the software programming was conducted by Nimira Kurji, Delcan Corporation. Assistance in the testing of the software was provided by Stepanka Elias, a former employee of Delcan and now a research assistant at the University of Toronto. The bulk of the work was done under the direct supervision of Hugh Hawk. Background material was coordinated by Dr. Sinha, and the State-of-the-Art Study was conducted by Dr. Lemer.
This report contains the findings of a study to develop a methodology for bridge life-cycle cost analysis (BLCCA) for use by transportation agencies. The report describes the research effort leading to the recommended methodology and includes a guidance manual for carrying out BLCCA and software that automates the methodology. The material in this report will be of immediate interest to engineers concerned with the life-cycle cost analysis of major bridges.

Transportation officials consider life-cycle cost analysis an important technique for assisting with investment decisions. Several recent legislative and regulatory initiatives recognize the potential benefits of life-cycle cost analysis and call for consideration of such analyses for infrastructure investments, including investments in highway bridge programs. Because a commonly accepted, comprehensive methodology for bridge life-cycle cost analysis (BLCCA) did not exist, NCHRP Project 12-43 was initiated.

Under NCHRP Project 12-43, National Engineering Technology Corporation developed a comprehensive procedure for life-cycle cost analysis. Of particular note is the explicit introduction of vulnerability and uncertainty in the analysis. Consideration of vulnerability and uncertainty results in a more realistic estimate of life-cycle cost. Although default values are provided for cost parameters, users will benefit from the development and use of parameters specific to the structure and environment in question.

The proposed methodology is fully described in the Guidance Manual (Part II of the report). The methodology is implemented in software contained on a CD bound with the report (CRP-CD-26). The report appendices, the Guidance Manual, and a User’s Manual are accessible from the software. The User’s Manual presents four examples of the application of the methodology.
BRIDGE LIFE-CYCLE COST ANALYSIS

SUMMARY

NCHRP Project 12-43, “Life-Cycle Cost Analysis for Bridges,” has resulted in NCHRP Report 483 and CRP-CD-26, which can be used by professionals to undertake life-cycle costing analysis for bridges. The report has two parts. Part I (the Report) establishes guidelines and standardizes procedures for conducting life-cycle costing. Part II (the Guidance Manual) is useful to all professionals engaged in life-cycle cost analysis either for the repair of existing structures or for the evaluation of new bridge alternatives. The Guidance Manual outlines the concept of life-cycle costing, identifies sources for data, and explains the methodology by which life-cycle costing can be conducted.

CRP-CD-26 contains the appendixes to the Report (Appendixes A, B, D, and E; Appendix C is the Guidance Manual); the User’s Manual and Guidance Manual both as Word documents and in portable document format (pdf); and the bridge life-cycle cost analysis (BLCCA) software. The BLCCA software provides a tool for professionals to apply the life-cycle cost-analysis concepts and methodologies to the analysis of bridges. The software considers agency and user costs and enables the user to consider both vulnerability and uncertainty in the analysis.

In combination, the Report, Guidance Manual, and software are a powerful tool that can be applied to the decision-making process for the repair or selection of cost-effective alternatives for the preservation of bridge assets for short-term and long-term planning horizons. NCHRP Report 483 and CRP-CD-26 are companions to the network-based Bridge Management Systems.