Identifying Number MPC-351

Project Title:

Concrete Structure Design Alternatives for Rural State and Local Roads

University:

South Dakota State University

Principal Investigator:

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Description of Research Problem:

State and local governments must address the ongoing need for replacement of bridges and box culverts. Especially on local road systems, a significant portion of structures have far exceeded their expected lives and have become structurally or functionally obsolete.

In many situations, cast-in-place and precast concrete structures are sound, economical replacement alternatives involving some tradeoffs. Cast-in-place structures generally offer excellent performance, but may require longer construction duration and more complex on-site effort. In contrast, precast structures can offer simpler and quicker on-site construction, but occasional problems with performance have been reported. While the relative initial economy of cast-in-place and precast construction methods can be determined from construction bid prices, long-term or life-cycle costs (which depend upon performance) are not well established. Furthermore, it is possible that the selection of the most cost-effective construction method depends upon specific site conditions or design requirements. For example, one type may more effectively address short span lengths, box culvert cross-sections, or stream flows.

To enable local and state transportation agencies to invest their limited funding most effectively, research is needed to provide guidance regarding selection of the most cost-effective concrete bridge construction designs and methods suitable for South Dakota.

Research Objectives:

The objectives of the proposed study include:

1) Identify and describe current and recent cast-in-place and pre-cast concrete bridge and box culvert designs commonly employed in South Dakota;
2) Analyze the performance and cost-effectiveness of in-service bridges and box culverts constructed according to the identified cast-in-place and precast designs over the range of site conditions prevalent in South Dakota;
3) Provide guidance for selection of concrete structure type on state and local roads in South Dakota.

Research Approach / Methods:

The proposed study will include following Tasks:

Task 1: Literature review. Literature regarding design, construction, and performance of precast and cast-in-place construction of rural bridges and box culverts will be identified and reviewed.
Task 2: Design review. The bridge management database maintained by the South Dakota Department of Transportation will be queried to identify the predominant concrete precast and cast-in-place designs employed on state and local roads.
Task 3: Survey of owners and builders. State and local highway officials, as well as representatives of the construction industry, will be interviewed or surveyed regarding their experience in building and maintaining concrete precast and cast-in-place structures.
Task 4: Performance analysis. The bridge management database maintained by the South Dakota Department of Transportation will be analyzed to characterize the performance and maintenance demands of concrete precast and cast-in-place structures over the range of conditions experienced in South Dakota.
Task 5: Design recommendations. On the basis of design review, survey of owners and builders, and analysis of performance and maintenance history, identify critical factors adversely affecting the life and performance of precast and cast-in-place structures and potential countermeasures.

Task 6: Economic analysis. Based upon historical construction and maintenance costs, the cost-effectiveness of concrete precast and cast-in-place structures will be assessed over the range of conditions experienced in South Dakota.
Task 7: Final report. A comprehensive report will be prepared which summaries the literature review, research methodology, findings, conclusions and recommendations.

MPC Critical Issues Addressed by the Research:

1. Improved Infrastructure Design
2. Infrastructure Longevity
3. Economic Analysis of Investments and Impacts

Contributions/Potential Applications of Research:

Successful completion of this research will provide valuable guidance to state and local agencies regarding effective investments in bridge and box culvert replacement. The research will directly influence the type selection and design of structures on state and local highway systems and will enable more effective investment of limited bridge replacement funding.

Potential Technology Transfer Benefits:

Application of this research will result in more effective investment of public funding and improved service to users of state and local roads. Students will be trained on the analysis and practical application of bridge performance data through involvement in the research.

Time Duration:

July 1, 2010 – June 30, 2011

Total Project Cost:

$64,344

MPC Funds Requested:

$33,000

Source of Matching Funds:

SDDOT and SDSU: $33,344

TRB Keywords: Cast-in-place structures, Precast structures, Cost effectiveness, Bridge type selection.