NCHRP

REPORT 801

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Proposed Practice for Alternative Bidding of Highway Drainage Systems

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CHAPTER 1

Background

1.1 Research Problem Statement

The United States invests billions of dollars in road infrastructure each year, with a significant portion of these costs going to drainage components. Given the scale of investment, as well as tightening budgets, it is more critical than ever to optimize value across all areas of transportation projects. The last few decades have seen huge improvements in drainage pipe materials and products. However, these innovations have yet to be fully embraced by agencies and individual design firms, because it is difficult to keep up with the vast array of new pipe options and individual pipe systems.

Designing, specifying, and bidding drainage pipe systems for highway projects are generally routine activities that occur on virtually every highway construction project. Because most pipe systems by their nature are routine, and separately are relatively low cost items, there is little incentive on individual projects to go beyond the basic task of identifying a system that works. Thus, the extensive database that exists on this topic addresses all the basic design issues, but generally fails to define a logical design practice that is (a) thorough, (b) comprehensive, and (c) does not stop when the first viable design option is found, but instead, finds every viable option that will meet an owner-agency requirement in terms of function and performance. While in most instances the traditional "means and methods" specification approach to tender delivers a serviceable drainage system, it severely limits competition among the manufacturers and suppliers of pipe products. The process can be further impaired by a lack of understanding of drainage pipe alternatives or by misconceptions about the suitability or relative performance of different pipe systems.

If transportation projects took full advantage of available drainage-system technology, value could be significantly increased. Giving contractors the ability to choose, at the bidding stage, from among alternative solutions that are of satisfactory quality and equally acceptable on the basis of engineering design criteria has been shown to promote competition and lower costs.

1.2 Objective of NCHRP Project 10-86

The general objective of NCHRP Project 10-86 is to develop a procedure suitable for adoption by American Association of State Highway Transportation Officials (AASHTO) to guide owner-agencies and industry in the implementation of performance-based procurement for drainage systems on highway construction contracts.

A solution lies in an approach that allows all pipe products on the market to be objectively categorized by assessing their quality, performance, and serviceability; by making this information readily available to agencies and their designers; and by creating a streamlined (and preferably automated) design and selection process that allows a rapid and reliable selection of suitable pipe systems for a particular application. This approach will allow all acceptable pipe systems to be included in a roadwork's tender on an equal footing.

The NCHRP Project 10-86 research team was assigned to devise a system that is technically sound, that is versatile (i.e., can be adapted for any jurisdiction in any geographic location), and that can deliver better performing highway drainage systems on a much more cost-effective basis than the traditional approaches to drainage system design and procurement.

Specific objectives of NCHRP Project 10-86 were to perform the following:

- Review and consider the state of the practice regarding drainage systems.
- Develop a Recommended Practice for pipe system evaluation that encompasses key factors controlling pipe materials and performance (site characteristics, strength, hydraulics, durability, constructability, construction and post-construction costs, maintenance, and rehabilitation).
- Evaluate the Recommended Practice through trial applications representing a variety of geographical and use conditions in cooperation with a number of state DOTs.

of estimated and actual material service lives will allow for research and data-mining to improve and calibrate existing culvert design methods through feedback loops within the Recommended Practice. Specifically, the developing research topics of service life prediction and failure modes can be significantly improved through the tracking and sharing of actual drainage pipe system service life data across and within AASHTO agencies.

The Recommended Practice could also form the basis to simplify and facilitate a highway drainage asset management system by tracking and integrating system feedback based on the transparent processes included in the Recommended Practice. The independent parallel assessment for each functional/technical category used in the Recommended Practice allows the designer to observe why a pipe system was determined to be unsuitable. Regular agency review of technical evaluation results and trends in bidding and field performance are encouraged for incorporation into agency policy reviews and updates.

5.4 Recommended Use

The selection and design of drainage pipe systems for use in transportation projects depends on both economic and technical considerations. Individual agencies currently develop and maintain independent policies to guide the design, bidding, post-construction inspection, and long term asset management of highway drainage pipe systems. This Recommended Practice is intended to provide a national AASHTO standard for agency implementation of drainage pipe system evaluation and alternative bidding to foster greater harmonization and standardization across AASHTO agencies. With implementation, it should serve to reduce costs through more efficient design, identification of cost-effective solutions, and increased local competition between contractors and suppliers. It should also encourage the development of better pipe products and the formation of a national marketplace for drainage system pricing as policies become more nationally standardized.

The current functionality of the Recommended Practice is that it selects pipes that have an EMSL that is longer than the desired DSL. However, as EMSL methods improve, the Recommended Practice could facilitate application of a life cycle costing approach to pipe selection whereby even pipes with EMSLs less than the DSL could be selected provided their service life could be extended by in-situ remediation. This would allow even more options to be considered and could facilitate a "staged-construction" approach to drainage design.

Traditionally, transportation agencies have used a "means and methods" approach for selection and specification of products such as drainage pipe systems. In this approach, the agencies specify a particular drainage pipe system during the design process and the cost of the specified system is included in the contractors' bids for the project. This system often restricts or impedes competition by eliminating many technically suitable alternatives. The inclusion of multiple equivalent options during the bid phase of projects has been shown to reduce costs through increased competition.

This Recommended Practice presents a methodology to guide transportation agencies in implementing a performance-based process for evaluating alternative drainage pipe systems with the intent to increase competition and reduce costs while maintaining safety and performance standards. The Recommended Practice contains elements to guide development of a holistic program that would allow for systematic inventory management and tracking of results that could improve service life predictions and lead to better management of highway drainage assets.

The Recommended Practice applies rational performance-based criteria to the selection of pipe systems. It is not intended to be a stand-alone design document, but rather a design guidance and process framework when used in conjunction with other resources including AASHTO LRFD, FHWA Hydraulic Design procedures, and agency policies and design manuals. This methodology promotes the implementation of the latest national standards and other state-of-the-practice design evaluation methodologies with the intent of being as comprehensive as possible while also allowing the flexibility to incorporate agency-specific standards or requirements. The matrix approach developed for technical evaluations within the Recommended Practice is intended to provide clarity of design decisions and to allow for data tracking and mining for future agency use or for research to improve policies and methods.

The Recommended Practice methodology presents a simplified systematic process for identifying drainage pipe systems for a specific defined application based on the application of hydrological, hydraulic, structural and durability principles. However, it is expected that the Recommended Practice be applied only by engineers experienced in drainage pipe design principles and that the use of the Recommended Practice will not eliminate the need for the results to be reviewed and checked by a drainage design engineer. The Recommended Practice incorporates a final design check step to allow for more detailed analyses, where necessary, beyond the basic evaluations and to allow for agency- or project-specific provisions to be applied.

The Recommended Practice addresses the design of circular and standard elliptical and closed arch (i.e., pipe arch) drainage elements. Large and special design drainage pipe systems such as box culverts, large span open bottom arches, pressure pipes, and so forth are not directly addressed or incorporated. Above all, the Recommended Practice is intended as a streamlined process for the design of routine highway culvert and storm sewer systems.