SIZING OF HIGHWAY CULVERTS AND BRIDGES: A HISTORICAL REVIEW OF METHODS AND CRITERIA

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RESEARCH

Introduction

This report examines the methods and criteria that highway engineers have used to size culverts and bridges in Kansas and throughout the U.S. from the start of highway construction to the present. The focus is directed to methods actually employed by highway engineers rather than methods described in the research literature. Hydrologic methods are categorized as early or modern, according to whether a specific recurrence interval is associated with the design. Modern hydrologic methods are based on statistical analyses of systematic records of streamflow or rainfall data; the desired recurrence interval is an input to the design.

Project Objective

In the early days, culverts and bridges were sized by empirical methods developed from experiences with existing structures during floods. Most of these methods were developed by or for the railroads. No particular recurrence intervals were associated with the resulting designs. Early highway engineers were aware of the shortcomings of these design methods, but they were hampered by a shortage of reliable streamflow data and rainfall data. The transition to modern frequency-based design methods generally occurred during the 1950s.

Project Description

The highway-building era in Kansas began in 1917 with the creation of the Kansas State Highway Commission (KSHC), the predecessor of the current Kansas Department of Transportation (KDOT, since 1975). Prior to the mid-1950s, most culverts and bridges on Kansas highways were sized with the Talbot formula, Dun's table and other empirical methods. KSHC and KDOT have employed frequency-based design methods such as the Rational method and U.S. Geological Survey (USGS) regression equations since the 1960s. Highway culverts and bridges have been designed for recurrence intervals of 25 years or greater over this period. The hydrologic methods and design guidelines employed by KSHC and KDOT have been within the mainstream of highway engineering practice nationwide. Hydrologic methods have been improved as more streamflow data have become available. However, flood frequency estimates for small watersheds still have large standard errors.

Project Results

The federal government has specified a minimum recurrence interval of 50 years for culverts and bridges on Interstate highways since 1956. However, FHWA and its predecessors have never specified hydrologic design criteria for structures on non-Interstate highways.

The engineering professions understanding of culvert and bridge hydraulics has advanced greatly over the last century. The Talbot formula, Dun's table and similar empirical design methods did not explicitly consider the hydraulic characteristics of the structure. Modern design methods require hydraulic analyses of proposed designs. A series of technical reports published by U.S. Bureau of Public Roads in the 1960s provided highway engineers with practical guidance on the hydraulic aspects of culverts and bridges.

Report Information

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