OKLAHOMA Transportation

RESEARCH

PROJECT TITLE
DEVELOPMENT OF RATING TOOL FOR PRESTRESSED CONCRETE BRIDGES VULNERABLE TO SHEAR

FINAL REPORT ~
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HIGHLIGHTER

DEVELOPMENT OF RATING TOOL FOR PRESTRESSED CONCRETE BRIDGES VULNERABLE TO SHEAR

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OVERVIEW A large number of bridges in Oklahoma were designed and put into service between 1960 and 1990 using the quarter point rule for shear design using the AASHTO Standard Specifications (e.g. AASHTO 1973). This method considered the shear at the quarter-span point as the critical value for the design demand and often resulted in larger shear reinforcement spacings near the beam ends. The current AASHTO LRFD Specifications consider the critical location for shear to be much closer to the support, which can result in a larger design demand and smaller shear reinforcement spacings. According to ODOT engineers, as many as 1000 bridges in Oklahoma may have been designed using the quarter point rule for shear, potentially leaving these bridges vulnerable to a lower load rating compared to newer bridges when evaluated using the current LRFD Specifications. In addition, the effects of deterioration due to long-term exposure to the often-harsh climate of Oklahoma should be considered when calculating capacity for the girders. This study investigated the factors affecting shear capacity and subsequent load rating, evaluated two potential methods for assessing condition of in-service prestressed concrete bridge girders, and developed a simple methodology for assessing bridge rating for shear.

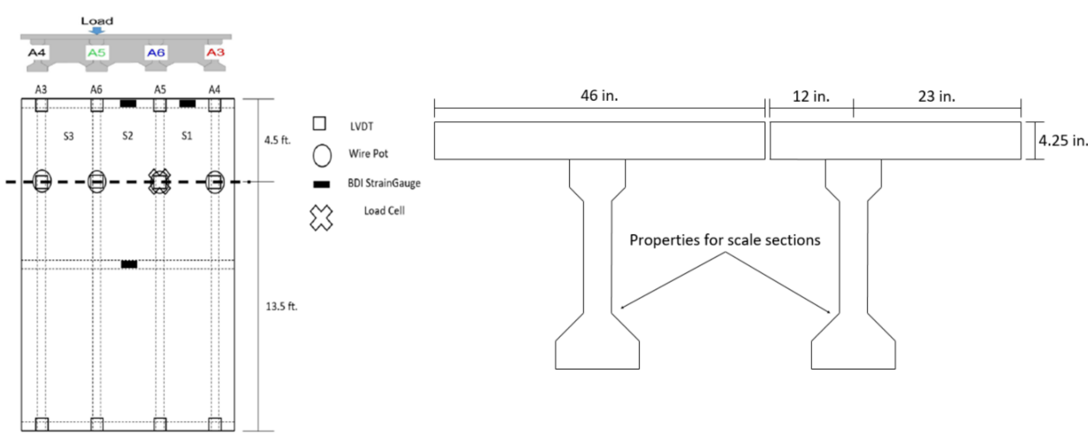

Figure 1 Section and plan of test bridge

RESULTS In this study, a detailed literature review was conducted on the bridge shear capacity calculation methods and to collect results of experimental shear testing on old prestressed concrete girders. This was followed by a parametric study to examine the effect of different design items on shear load distribution. For this purpose, the researchers used a simple method of computer analysis, known as grillage model. The benefits of using this method include ease of comprehension and use, inexpensive cost, accuracy, and applicability to a wide range of bridge types. All grillage models used in this study were built in the finite element analysis program STAAD.Pro made by Bentley Systems. Data from shear tests in Oklahoma, from the literature and results of grillage modeling of various bridge configurations were examined to identify factors affecting shear behavior during girder design and capacity analysis. Also, the difference between AASHTO load distribution equations and grillage models for more than two hundred different bridge configurations were investigated. Two methods for assessing the condition of in-service girders, based on end region bond behavior and flexural stiffness, were examined and further refined.

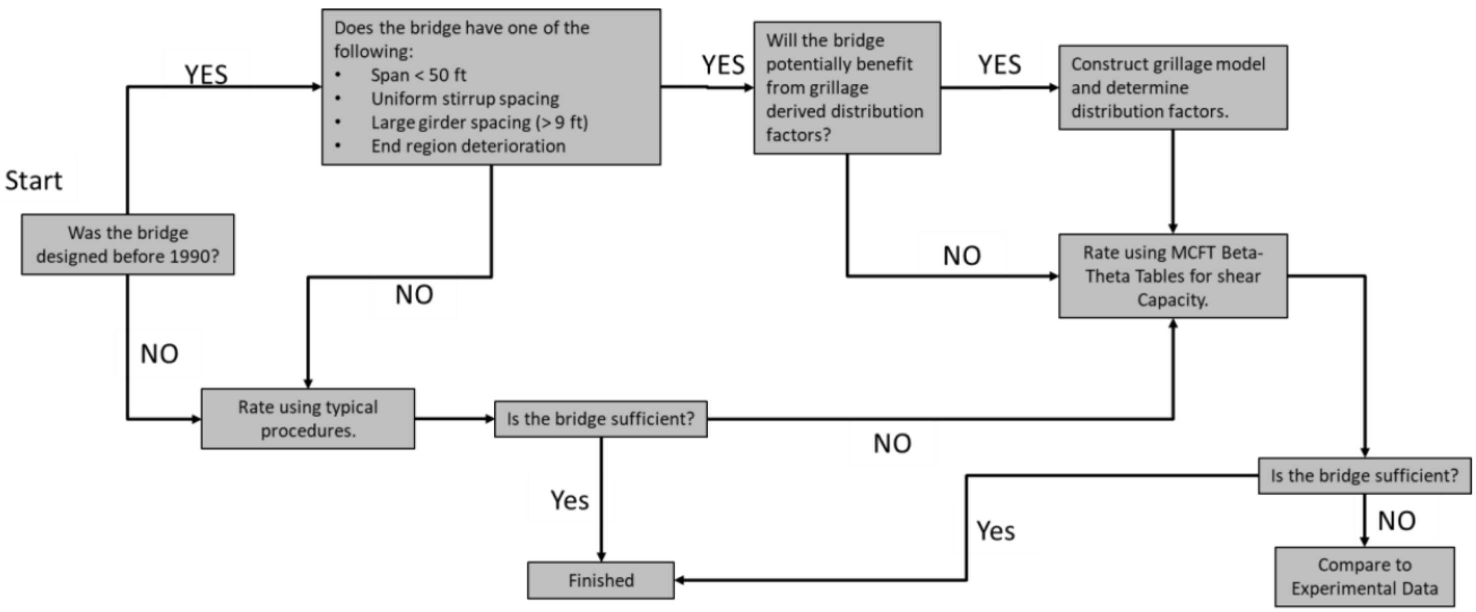

Figure 2 Flow chart of suggested procedures for examining bridges potentially susceptible to shear

A procedure for identifying and rating bridges that may be vulnerable to shear was described in the final report. When rating older girder bridges, it was observed that the AASHTO load distribution factors may add more conservativism to an already conservative process. Replacing the code shear distribution factors with grillage model derived distribution factors for load rating may be beneficial for these types of bridges. Using a grillage model can increase load ratings and reduce the potential need to take some bridges out of service without sacrificing accuracy and safety. The girders examined in this study mostly reached expected capacities despite differences in the code at the time they were designed. The AASHTO Modified Compression Field Theory (MCFT) methods were the best for use in rating older girders due to their balance of accuracy and conservativism. End region corrosion visible in the tested girders did not affect ultimate capacity, but potentially led to strand slip and influenced the failure mechanism. Based on the results of previous shear testing and the findings of the grillage models, there may be conservativism built in when AASHTO distribution factors and the MCFT methods are used. This leaves open the possibility of increased load ratings for some older bridges.

POTENTIAL BENEFITS As the state of Oklahoma pushes to get the number of structurally deficient bridges down to less than 1% of all highway bridges in Oklahoma by the end of the decade, it is important that additional bridges are not labeled structurally deficient, or load posted unnecessarily. In light of changes to the code, accurate load rating of bridges for shear is important to prevent adequate bridges from being rated deficient. This study generated necessary information on shear behavior of girders and developed a procedure using a set of simple criteria to identify bridges potentially vulnerable to shear. Also, modifications to the typical rating procedure to produce an accurate shear rating was proposed.