LOUISIANA TRANSPORTATION RESEARCH CENTER
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Investigating Available State-of-the-Art Technology for Determining Needed Information for Bridge Rating Strategies

INTRODUCTION

According to the bridge load rating group of the Louisiana Department of Transportation and Development (DOTD), there are about 8,000 bridges on the state system and 5,000 off-system bridges owned by various entities in the state of Louisiana. Title 23 of the US Code mandates states to inspect and evaluate all highway bridges for safety and serviceability. To comply with this code, all bridges in the state should be evaluated and rated on a regular basis.

DOTD has hundreds of bridges for which the as-built plans are missing or incomplete. The unavailability of the needed information will prevent the bridge rater from performing the calculation to decide whether to post such a bridge or not. This study identifies the best available nondestructive testing (NDT) for determining currently missing as-built information for these bridges.

A comprehensive literature review of the NDT methods was performed and a summary of the available methods is presented. The required parameters for a successful bridge rating for each type of bridge of interest are presented. Based on the needed parameters established by experienced bridge rating engineers, the most suitable technologies were selected for the measurement of the needed parameters.

OBJECTIVE

The purpose of this project was to search and report available technologies and their related costs to determine needed information for DOTD to perform the load rating for bridges that are missing as-built information. Examples of missing information include items that fall under geometry (such as bridge length, width, and other member dimensions) and items related to the strength of the bridge materials, concrete and/or steel, as well as reinforcing bar locations. Rating strategies will be developed based on the needed parameters for load rating of each type of bridge, such as concrete precast slab (COPCSS), concrete slab (COSLAB), and concrete pre-stressed channel (COPSCH), and to a lesser extent, pre-stressed girder bridges and steel bridges. Timber bridges were not included in this research per the original scope of work.

SCOPE

To determine the needed information, this report primarily focuses on the practice-ready NDT methods with an emphasis on the established national and international standard methods. If there is no standard testing method to determine any of the required information, then applicable NDT methods in the development phase (experimental) are presented. Successful application of the experimental methods cannot be warranted, and it may be required to perform some limited destructive testing to verify the results of the NDT tests.

METHODOLOGY

Bridge load rating is an important indicator for infrastructure management authorities. To perform a successful bridge load rating, critical information is required for each type of bridge.

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Four key steps are typically followed to complete load rating analyses: (1) collect member properties, (2) calculate dead loads, (3) determine member capacity and applied loads, and (4) calculate rating factor.

The first step involves the collection of data. If this information is not readily available, then a load rating cannot be performed successfully. This set of parameters was assembled for this report using the extensive experience of the authors and a literature review regarding the required information, software, and methods required to perform a load rating.

When bridge material and geometry data are missing, NDT methods offer the best means to safely and economically determine this information. To identify proper NDT methods for measuring the missing data for different types of bridges, the authors' extensive NDT experience was used to guide a thorough literature view of the available NDT methods from the civil engineering field as well as from related industries, such as aviation, chemical, nuclear, and electronic devices.

The deliverables for this research summarize the information required for a bridge load rating by bridge type and also present the technology available to gather missing information with an analysis of how this technology can be used to determine each parameter required for a bridge rating.

CONCLUSIONS

The report concludes with a comprehensive and practical tabular presentation for each major bridge type and the required as-built information. These tables provide each required parameter and the NDT methods available to obtain that information. Each NDT method is rated based on cost, ease of use, and data reliability.

These tables are organized by the following bridge types:

- Concrete precast slab bridges (COPCSS) and concrete slab bridge (COSLAB)
- Concrete prestressed channel bridge (COPSCH)
- Prestressed girder bridges
- Steel bridges
- Steel bridge connections

Under each bridge type, the results are organized into the following categories of information:

- As-built geometric parameters
- As-built strength parameters
- As-inspected strength parameters

RECOMMENDATIONS

Nondestructive testing methods were evaluated to obtain various required parameters for performing a bridge load rating of different types of bridges. The required parameters are categorized into three categories: as-built geometric parameters, as-built strength parameters, and as-inspected strength parameters. The following recommendations are obtained from this study:

1. Based on the findings, availability of the equipment/service, and common practice, the recommended methods of identifying the major load rating parameters are:
    - As-built geometric: Direct measurement, GPR, Impact Echo, Ultrasonic Echo, Cover meters and Radiography
    - As-built strength: Core testing, Rebound, Penetration Resistance, GPR, Covermeters, and Radiography
    - As-inspected strength: Visual Inspection, Impact Echo, Impulse Response, Half Cell, and Radiography

2. The following parameters currently do not have nondestructive testing methods available and warrant further research by the industry:
    - Yield strength of steel embedded in concrete
    - Prestressing forces of strand embedded in concrete
    - Extent of debondment of reinforcing steel that is not visible
    - Bond zone of prestressing steel embedded in concrete