Louisiana Transportation Research Center

Technical Summary

LTRC Report 703

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Skew Detection System Replacement on Vertical Lift Bridges (Phase 2)

Introduction

Louisiana has over 140 movable bridges, including more than 40 vertical lift bridges. A potential vulnerability of a tower drive vertical lift bridge is a failure to maintain level operation over the length or width of its span; this is known as longitudinal or transverse skew, respectively. When either of these conditions occur, they can cause the movable span to jam in its guides; without adequate protection, this can lead to a catastrophic bridge failure.

Vertical lift tower drive skew indication and monitoring has historically used a differential synchro (i.e., Selsyn) system. However, this technology is now considered obsolete, and replacements are difficult to obtain. A study was commissioned to evaluate alternatives to the differential Selsyn system. These alternatives were selected based on several criteria, including their availability, ease of maintenance and replacement, and minimization of the use of advanced electronic equipment.

Figure 1. Ellender Ferry Bridge, SR 27, Calcasieu Parish, Louisiana

This report summarizes Phase 2 of the study. In this phase, several alternative skew detection methods from Phase 1 of the study were field-tested and evaluated.

Objective

The objectives of Phase 2 of this study were to develop documents for the installation and testing of potential replacements for the differential Selsyn system skew control which meet DOTD criteria and provide a report evaluating these alternatives. The evaluated technologies were chosen based on the findings of Phase 1 of this study and were deployed at the Ellender Ferry Vertical Lift Bridge over the Intracoastal Waterway located in Calcasieu Parish, Louisiana.

Scope and Methodology

The scope of Phase 2 of this study was to develop documents for the installation and testing of potential replacements for the differential Selsyn system skew control, analyze the performance of selected skew control systems, and determine the preferred system for future use on new and existing DOTD bridges.

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The initial design for the field-testing of the alternative skew system replacements at the Ellender Ferry Bridge was based on a review of the existing bridge system, including the use of existing as-built drawings and a field inspection. The design of the system for testing was based on the Phase 1 report, WJE's experience on other lift bridges, and the established design criteria list. Once the designed system was installed and calibrated, it was tested for accuracy and performance. Established evaluation criteria were used to provide an assessment of each alternative system and sub-system against a common base. The developed criteria included all elements required for a fully functional system. The evaluation criteria were configured as a decision matrix tool to provide an unbiased selection of the preferred system for future use on new and existing DOTD bridges.

Conclusions

Ellender Ferry Bridge, which was selected for this phase of the study, lacked an operational skew monitoring system that could be used for comparative purposes as part of the study.

Sampling limitations and network shortcomings led to an incomplete evaluation of the selected alternative forms of skew monitoring.

Data communication, network selection, and installation are critical to the success of modern skew indication systems. This is especially true when retrofitting existing movable bridges and utilizing their existing wiring infrastructure, as in the case of the Ellender Ferry Bridge. For hardwired signals, shielded-twisted pair lines or fiber optic cables are essential for data transmission, as evidenced by the failure of data transmission using Power Line Communication for the inclinometer and the use of the existing aerial cable (i.e., south tower encoder signals, with SHDSL modems). Where suitable conductors are not available, consideration should be given to installing manufacturers' recommended cables. However, this study has demonstrated that wireless transmission can at times be a successful substitute for hard wiring.

To achieve a reliable and accurate form of skew indication, it is important that the selected SMART relays, network application, and wiring provide a high sampling frequency (100 Hz) and data transmission integrity.

Despite the limitations of the data recordings, it is clear from this study that the selected alternative systems provide reliable skew position indication and are viable alternatives to the differential Selsyn system.

All three devices provide suitable skew measurements. However, the encoder and inclinometer both offer clear advantages, including ease of setup, maintenance, simplicity, and environmental resilience. It is concluded that all three considered alternative skew systems can be reliably used to monitor, alarm, and control skew conditions.

Recommendations

The following recommendations are provided for the deployment of alternative skew monitoring equipment on movable bridges:

1. Provide a redundant system that utilizes absolute encoders for indirect skew measurement and an inclinometer for direct skew measurement.
2. The SMART relay selection and network design must ensure sufficient sampling frequency and reliable and stable data transmission.
3. Proper cabling must be used for communications signal transmission. Data transmission through Power Line Communication is likely not a suitable method for movable bridges. If using existing conductors, the data transmission must be through appropriate shielded, twisted-pair conductors.
4. Where the proper conductors are not available, wireless transmission of data should be considered. When specifying wireless systems, use directional antennae instead of omni-directional antennae. Additionally, select antennae with a large beam widths, which would allow for easier alignments.
5. During the installation of the systems at the bridge, oversight of the installation is strongly recommended to ensure proper installation practices are followed and that installation issues do not impact data transmission and the integrity of the installed network.