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Evaluation of CX1 Structural Dynamics Monitor

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Introduction

Monitoring of the in-field performance of bridges and other structures has become a very valuable tool to the Iowa DOT Office of Bridges and Structures. There simply is no better way to understand how structures react to loadings than by physical monitoring and testing. There are a large number of monitoring tools that are commercially available. One such tool is manufactured by an Iowa-based company known as SENSR. The SENSR hardware consists of tri-axial accelerometers, tiltmeters and temperature sensors. The unique nature of the SENSR hardware is that it is easily deployable by personnel with only a limited amount of training.

To evaluate the SENSR system, the Bridge Engineering Center completed two tasks. First, the SENSR system was installed on a laboratory specimen adjacent to sensors with known performance characteristics to validate the accuracy of the SENSR system. Second, the SENSR system was field installed to understand how to install and utilize collected field data.

Laboratory Evaluation

In 2014, the SENSR system was installed on a laboratory specimen undergoing testing as part of an on-going project (see Figure 1). As can be seen in Figure 2, the SENR sensor was installed adjacent to a traditional tilt sensor and data collected for both during a portion of testing (note that data were not collected for the duration of the test as to ensure that the SENSR system was not damaged).

Figure 1. Photograph of Experimental Test Setup

Figure 2. Photograph of SENSR Sensor and Conventional Tilt Sensor

During testing, both sensors were monitored until the first load level had been achieved. At that time, the SENSR system had recorded 0.258 degrees of rotation and the conventional tilt sensor had recorded 0.269 degrees of rotation – a difference of 4.1%.

Field Installation

A In the Spring of 2019, the SENSR system was deployed on a bridge on I-29 in Southwest Iowa for the purpose of monitoring pier movement following a historic flood event as well as during subsequent repair of the bridge (see Figures 3 and 4).

Figure 3. Photograph of SENSR System Deployed on I-29 Bridge

Figure 4. Photograph of SENSR System Deployed on I-29 Bridge

Installation of the system was easily completed taking two engineers approximately 1.5 hours to complete. Once the system was powered, data were immediately transferred to cloud-based storage where they could be analyzed in real time. The system was configured such that if the measured tilts

exceed a pre-set amount, that a text message would be sent to pre-determined people (in this instance Iowa DOT, Iowa State University, and HDR staff members). A typical graph of data collected is shown in Figure 5.

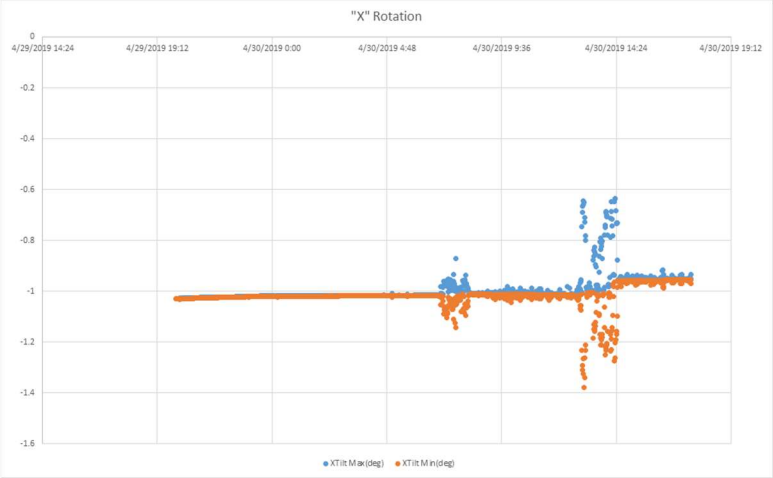

Figure 5. Example of I29 Tilt Data

Concluding Remarks

In this evaluation, the efficacy and the usability of the SENSR system was evaluated through a controlled laboratory test as well as a real-world application. By all accounts, the SENSR system is an accurate, easy to install, and easy to use system. The Iowa State University Bridge Engineering Center maintains this system in a "ready to deploy" state if and when the Iowa DOT requires its use.