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THE HAN-ONLINE BRIDGE SAFETY MONITORING SYSTEM AND AN APPROACH TO BETTER BRIDGE MAINTENANCE

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Abstract

This paper describes a new method and technique adopted for the "Hangang Online Safety Monitoring System Project" that will enhance the bridge maintenance practices of 6 main bridges crossing the Han River in Seoul, Korea. Bridge instrumentation has been an integral part of recently built long span bridges in Korea for about 10 years. The Hangang Online Safety Monitoring System Project presents a new unified methodology and software for managing different types of bridge monitoring systems and evaluating the status of the structure from measured results. Several methods to interpret both dynamic and long-term behavior of the structure from monitoring systems to help bridge maintenance have been applied. A new attempt to measure the clamped Nielsen arch hanger cables was devised. The high speed internet technology and web-based monitoring software provides a convenient way to evaluate the current health status of important bridge components, and thus presents a better tool to maintain bridges.

INTRODUCTION

Bridge instrumentation has been introduced in Korea for about 10 years. Most recently built and proposed long-span bridges have monitoring systems, and there is a variety of hardware and monitoring software available. In 2002, when the Kyungki provincial government handed over Sinhangju Bridge to the Seoul Metropolitan Government (SMG) had to manage 3 instrumented bridges and each monitoring systems were different in hardware and software. The bridge safety inspection report and relevant study for implementing bridge instrumentation suggested that in all the bridges crossing the Han River, 3 existing bridge monitoring systems needed upgrades, and 3 more bridges needed to be monitored. A new guideline for the overall system integration including data logging hardware, communication technology, and software was needed. The threshold for each measured response was determined based on specs and structural analysis. Statistical analysis was used to analyze long-term behavior. This paper provides A brief description of the integrated system configuration and the monitoring software of the Han-online Bridge Safety Monitoring system project.

THE HAN-ONLINE BRIDGE HEALTH MONITORING SYSTEM

The Han-online Bridge Safety Monitoring system project was a 3 year long project. In the 1st year, 3 existing instrumented bridges were upgraded and integrated into a new system. Several sensors were replaced and moved to better locations to measure the response. It was determined that data acquisition and all related data processing should be performed in local bridge levels. The data base server and web server run in the integration server, so a local server computer was installed in each bridge. High speed internet lines (ADSL) was sufficient to provide the bandwidth for the most heavily instrumented bridge. Fiber optic cables were installed to connect ADSL lines to the local servers.

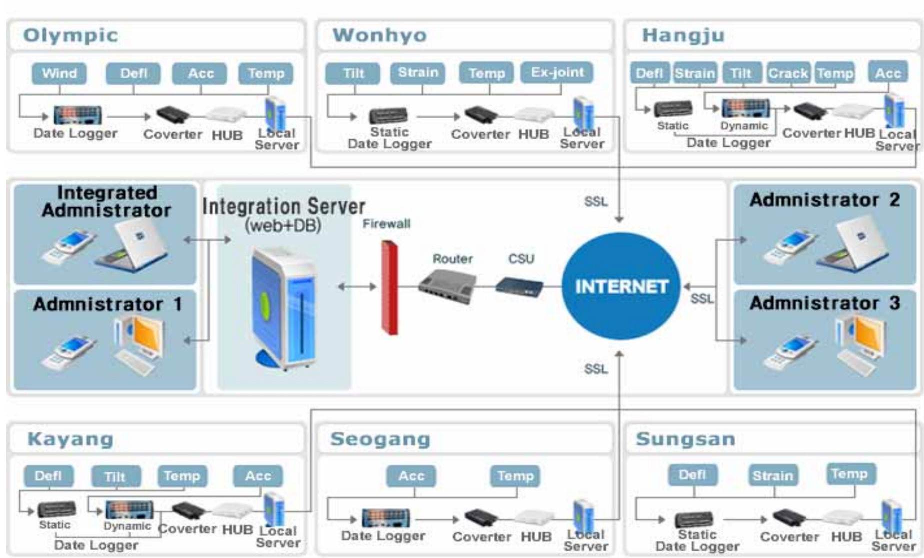

Figure 1. The Han-online system Configuration.

Data acquisition server programs that process both static and dynamic data logger were developed. The DAQ server program placed processed results in a local database. The database structure and algorithms to process data were optimized for web-based configuration. Proper threshold values were selected based on specifications and analyses. Field tests using loaded trucks were used to ensure the structural analysis results.

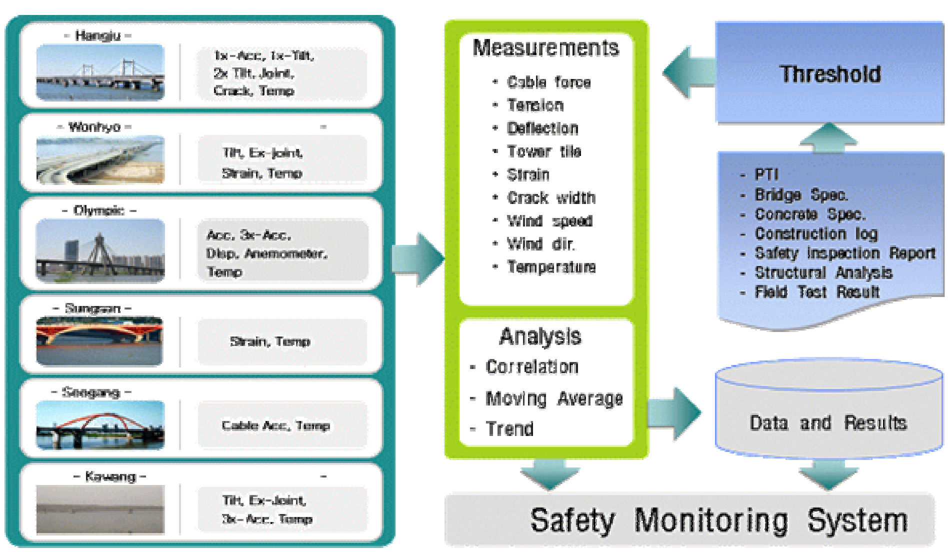

Figure 2. The Han-online system Evaluation Flow.

Web-based monitoring software was chosen for its accessibility and approachable interface. By placing the Han-online website on the internet, the SMG could promote its continuing effort to ensure public safety to the citizens of Seoul, and many interested citizens could learn of the nature of instrumentation and bridge structures.

Figure 3. Public Access Page.

Figure 4. Bridge desction for public.

The monitoring software was designed for SMG engineers who do not have specific knowledge for data acquisition and interpretation of measured data. The difference from the public page is that the processed data are provided and health evaluations could be performed. Fig.5 shows the current status for all 6 bridges by indicators and values. Fig.6 is bridge specific status pages with indicator and value. If something goes wrong, the indicators change color and blink. The Short Message Service (SMS) manager will send out a SMS message to all pre-selected people that need to know this information.

Figure 5. Integrated current status.

Figure 6. Bridge specific current status.

The Han-online system has 2 cable stayed bridges and a Nielsen arch bridge. Since cable force directly shows the cable configuration and overall geometry of cable structures, the monitoring system calculates the cable force out of cable acceleration in real time. Fig.7 shows acceleration measurement of single cable and its calculated cable force in real time. Multiple real time cable forces are drawn in Fig.8, with threshold values and initial values shown. It was found that cable forces for Nielsen arch cables that are clamped at the intersection could also be evaluated using an accelerometer.

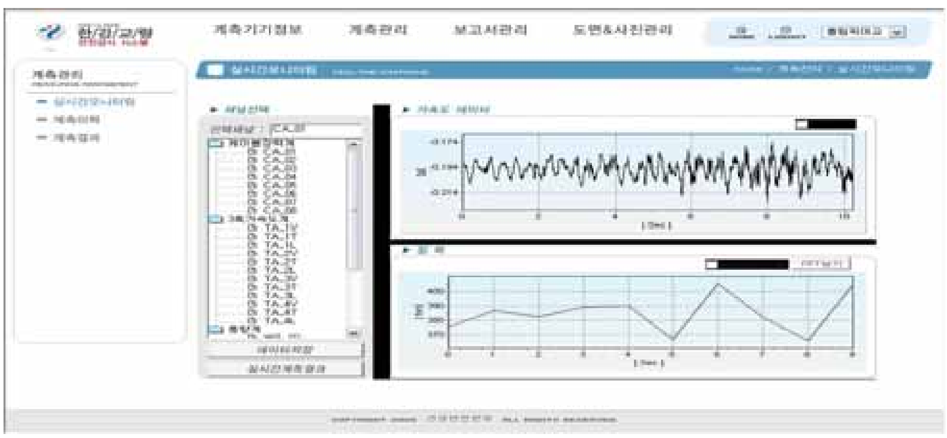

Figure 7. Single cable force realtime.

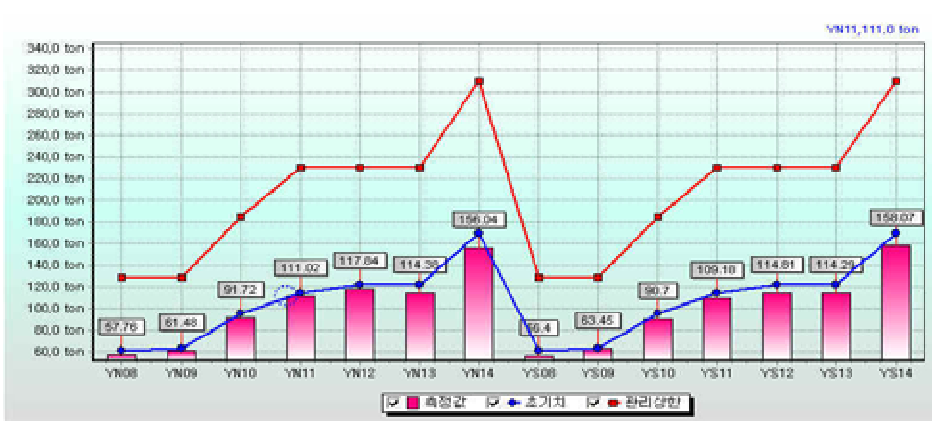

Figure 8. Multipla cable force realtime.

The report management system was included to help obtain and manage external professional advice on monitored results. The automatic report generation greatly reduces report writing time by including all required data and figures. This report is sent by e-mail to consultants when needed and commented reports are obtained under the report management system.

Figure 9. Report Management.

Figure 10. Daily report.

CONCLUSIONS

The number of instrumented bridges has increased over past years in Korea and so has the number of local governments that need to manage it. Bridge instrumentation is designed to assist in evaluating the health status of a bridge by providing continuous response monitoring and the analysis of data for years to come. But in real practice, it can perhaps become one more troublesome system to manage; and not helping managing bridge management.

This project is the first effort made by the SMG to reduce the management effort of bridge health monitoring systems, and to put more effort in evaluating the safety of bridge structures. The integrated system has been an efficient way to handle multiple bridge monitoring systems.