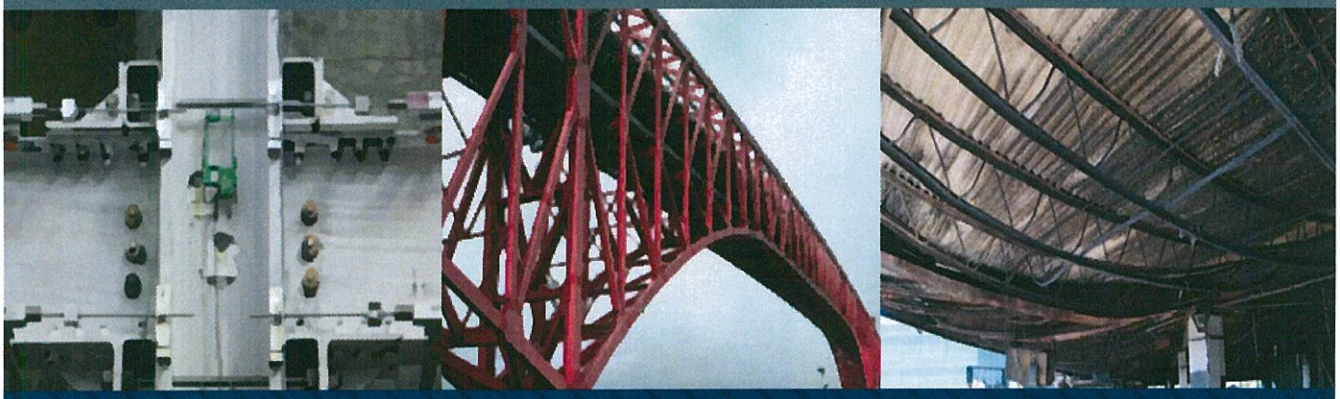

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Influence of the Data Filtering and the Attachment State of Sensor on Measurement Data in BHMS

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Abstract

Recently, the bridge management institutions due to an increasing construction of long span bridges and types of various structure are carry out a bridge health monitoring system (BHMS) for efficient a long-term operation and maintenance of a bridge. This paper provides an Influence of the data filtering and a measurement data according to the attachment state of sensor's jig on a girder. A sensor is a strain gauge which is located on 1/2 of middle span and connected to dynamic data logger (NI Compact Rio) in Inchon Bridge Monitoring System (ICBMS). As a result, in this study, a reflected data of a dynamic characteristic of the bridge was skillfully obtained by the filtering techniques using remove a noise data of on site. Also, there was reflected to the data of a dynamic characteristics in bridge that used a method of the welded sensor's jig on girder than used a method of bonded with epoxy of the sensor's jig on girder. however A result of data analysis, the data filtering technology is a critical factor on measurement sensitivity and so it has been confirmed that removing noise through FPGA (Field Programmable Gate Array) which is one of filtering techniques, is more efficient to measure quality dynamic data. Therefore, if using FPGA of the data filtering technology and the method of bonded with epoxy of the sensor's jig on girder, bridge manager can be beneficial for suitable operation and maintenance of bridges.

Keywords: Long span bridge, Bridge health monitoring system (BHMS), Data filtering, Measurement, Dynamic characteristics

1. Introduction

Recently, as a number of long span bridges are constructed, the bridge management institutions are carry out a bridge health monitoring system(BHMS) for efficient a long-term operation and maintenance of a bridge. The Incheon Bridge which has the longest span among cable-stayed bridges in Korea has distinctive structural characteristics, unlike other cable-stayed bridges. For these characteristics, Incheon Bridge Corporation (IBC) has established and been operating Incheon Bridge Monitoring System (ICBMS) for the structural behavior analysis and the maintenance of Incheon Bridge. ICBMS constantly monitors of obtained data and analyzes the measurement data which is settled on the critical point of the bridge to characterize the static or dynamic properties of the bridge.

This paper was analyzing an effect of the data filtering and attachment states of jig on the measurement data collected from strain gauge which is located on 1/2 of middle span and connected to dynamic data logger(NI Compact Rio) in ICBMS.

2. Outline of ICBMS

ICBMS established after considering structural properties, main members, section change and workability. Incheon Bridge's overall view is shown in Figure 1 and design specification is shown in Table 1. Also, the present condition and data loggers are shown in Figure 2.

Figure 1. Overall view of Incheon Bridge

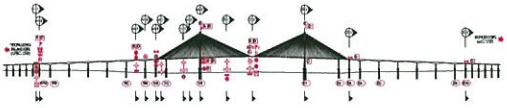

Figure 2. The present condition of ICBMS

Table 1. Design specification of Incheon Bridge

Items	Cable-stayed Bridge
Length	80+260+800+260+80=1,480m
Method	Cable-stayed Bridge PWS (Parallel Wire Strand Type)
Super-structure	Steel Box
Pylon / Pier	Reverse Y Type concrete Pylon
Foundation	RCD pile

3. Application Result of Data Filtering

Electrical signals always involve noise. Therefore, strain gauge, which is one of the electrical resistance type sensors, has numerous noises, too. But the electrical noise can be partly removed by statistical algorithm, because the electrical signals have specific distribution. In this study used algorithm removing these electrical noises. An approximate diagram about the algorithm used in this study is as following Figure 3.

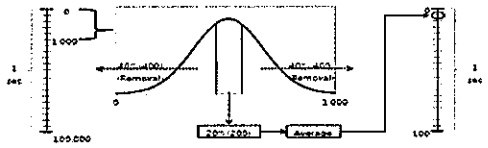

Figure 3. Diagram for the removing noise algorithm

The required sampling rates for dynamic characteristics analysis of bridge is 100Hz. Thus, the electrical noise can be removed by method that increase the sampling rates to 100,000Hz first and then takes the average of median 20%(200 samples) of distribution in 1000 samples. The data filtering is run in the dynamic data logger (NI Compact Rio) in real-time and the dynamic data logger (NI Compact Rio) output filtered 100Hz data.

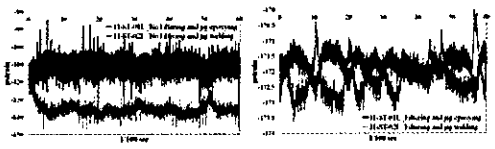

Figure 4. Non-filtered data(a) and filtered data(b)

Table 2. Deference in average of noise range by data filtering

Classification of Filtering	Sensor's Name	Ave. of Noise range	Attachment State
No Filtering	11-ST-01L	11.57㎲	Jig Epoxying
Filtering	11-ST-01L	0.55㎲	
No Filtering	11-ST-02L	3.92㎲	Jig Welding
Filtering	11-ST-02L	0.30㎲	

The result of analysis, as shown in Fig. 4 and Table 2, shows that the noise range of 11-ST-01L and 11-ST-02L decrease to 11㎲(95%), 3.62㎲(92%) according to the data filtering.

The result of analysis, as shown in Fig. 5 and Table 3, shows that the noise range of 11-ST-01L and 11-ST-02L decrease to 12.63㎲(76%), 0.25㎲(45%) according to the attachment state of jig. And the effect of the data filtering shows better result than the effect of the jig welding.

Also, noise range was lower sensor of welding jig than sensor of the attaching method by epoxy. But, sensor of the attaching method by epoxy is satisfied a resolution of sensor specification owing to under 1㎲.

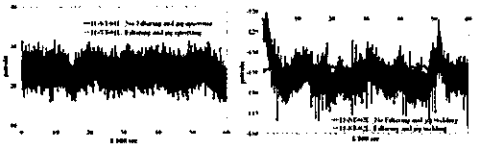

Figure 5. Jig attached by epoxy(a) and welded jig (b)

Therefore, it is better for bridge constructor and manager to use the attaching method by epoxy because it does less damage to structure, less cost and easier to construction than welding jig.

Table 3. Deference in average of noise range by attachment states of jig

Attachment State	Sensor's Name	Ave. of Noise range	Classification of Filtering
Jig Epoxying	11-ST-01L	16.55㎲	No Filtering
Jig Welding	11-ST-02L	3.92㎲	
Jig Epoxying	11-ST-01L	0.55㎲	Filtering
Jig Welding	11-ST-02L	0.3㎲	

4. Conclusions

The comparative analysis between non-filtered data and filtered data shows that removing noise by data filtering is able to get better dynamic data of bridge.

The comparative analysis of measurement data by attachment states of jig shows that the average of noise range in welding jig smaller than in jig attached by epoxy. But the data filtering is a critical factor on measurement sensitivity, so removing noise through filtering techniques is more efficient to measure quality dynamic data than welding jig.

The results of this study show that it is better for bridge constructor and manager to use the attaching method by epoxy because it does less damage to structure, less cost and easier to construction than welding jig.

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