Long Term On-line Health Monitoring of the Poyan Lake Bridge

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Summary

Because of recent disasters of bridges collapses in the world, preventive maintenance and structural safety of bridges especially for larger-scale bridges have become hot research direction in civil engineer. Strong attention has been paid to health-monitoring systems which can supply bridge manager with objective data for long-term damage prediction; safety evaluation and effective decision. The paper present and details the whole health monitoring of the Poyan Lake Bridge, and the system combines three models: on-line measure model; Power Data Transfers Model; Analysis Model. Finally the strategy for the health monitoring is proposed.

Keywords: health monitoring; on-line system; cable-stayed bridge

1. Introduction

The bridge is a PC cable-stayed bridge with 4-span girder of 65+123+313+130m. The bridge is near to the crossing of Yangtze Rive and Poyan Lake, where the strong wind often occur. The bridge has increasing traffic load, so it is essential to set up the on-line health monitoring system for the bridge.

2. On-line Measure Model

The on-line health monitoring model include six main on-line measure systems, Ambient Vibration Test system, Cable Force, Girder Deflection, , the Temperature, Girder Strain, Wind Speed and Direction.

2.1 Ambient Vibration Test System

The mechanics and physical performance of the bridge will change with its damage according to vibration test, so safety evaluation can been carried out by the performance measure system.

2.2 Cable Force System

Cable force measurement can be determined using vibration frequency of the cable.

2.3 Girder Deflection

A system of interconnected liquid levels, monitored with precision vibrating wire level sensors, and capable of automatically reporting accurate differential deflections to the automatic data acquisition system (ADAS) may eventually be used for the girder deflection measurement of the girder.

2.4 The Girder Strain and Temperature

Strains are measured using vibrating wire strain gages. Vibrating wire strain gages will be equipped with measurement of temperature at the gage location. Concrete temperatures are measured using Copper-Constantan Type ‘T’ thermocouples.

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2.5 Wind Speed and Direction

Strong wind will has great effects on the vibration. It is vital necessary to embed the instrument for the measurement about the wind speed and direction on the top of the towers.

3. Power Data Transfers Model

Measurement data from the sensors are sent to collection station, and then current data will be sent to Bridge Monitoring Centre, where amounts of data will be stored here. ADSL line has been implemented for transfer of all the data to the engineers or operators. An integrated Graphic User Interface (GUI) has also been put into use with the Visual C++ programming tool.

3.1 Real time Display

The systems demand all the sensors automatically collect the data at different intervals; on-line data can display conveniently on the engineer computer by Internet.

3.2 Detailed Statistical Recorder

A detailed statistical recorder of the long term health monitoring system can be obtained at any time from the remote operating.

4. Analysis Model

In the system of the health monitoring, the analysis method for evaluation of the bridge is pragmatically based on the combination of long term monitoring data, finite element analysis and regular inspection by engineers.

4.1 Long term monitoring database

It is important to set up the amount monitoring database of bridge condition including girder deflection, cable force, and girder vibration, simultaneously the temperature and wind condition also are recorded. So the main evaluation parameters will take change in the extent at given temperature and wind condition.

4.2 Finite element analysis

The finite element method is to perform static and dynamic performance of the structure under the wind, vehicle loading, and temperature change and so on. Frequencies and mode shapes can also identified by the FEM program.

4.3 Regular inspection

it is absolutely necessary to take four-annual regular inspections by trained engineers. Both on-line data and inspection data will be used to be compared.

5. Conclusions

In this paper, key technology issues of the three modules concerning long term on-line health monitoring have been outlined.

The system now is still under exploratory development. In this paper analysis system of the bridge mainly depends on the data from the system, considering the FEM result and regular inspection.

To summarize, long term bridge monitoring can provide quantitative data for network and bridge level management. Performance of the bridge from the system will undoubtedly contribute to safer operation, lower maintenance and development of evaluation method. Bridge safety is enhanced by measurement and monitoring of critical components of bridge.