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DETECTION OF ANOMALOUS STRUCTURAL BEHAVIOUR USING WAVELET ANALYSIS

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Structural health monitoring (SHM) can be defined as the continuous monitoring of a bridge's state properties, such as static and dynamic response, in order to diagnose the onset of anomalous structural behaviour. This involves measuring and evaluating the state properties and relating these to defined performance parameters. The process of measuring state properties, either continuously or periodically, produces large quantities of data and by careful analysis of these data, sudden and gradual changes in the bridge's behaviour can be identified and characterised. The ability of wavelet transforms to detect abrupt changes, gradual change beginnings and ends of events make them well suited for the analysis of bridge health monitoring data. This paper presents the application of wavelet analysis to identify events and changes in structural state in a bridge during and after its construction.
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1. INTRODUCTION

A healthy transportation system helps to sustain industry and commerce of any country by ensuring public safety and societal well-being. Bridges constitute significant and critical discrete components of such a transportation system and they are among the most expensive investment asset of any country's civil infrastructure. They also have a long service life compared with most commercial products and are rarely replaceable once erected. Many countries have recognised the importance of maintaining the health of their bridge stocks and to this end, numerous bridge authorities have introduced bridge management systems. Most current bridge management systems are based on visual inspections in which visual inspection data are assigned condition states, which are then interpreted to assess the condition of the bridge and project its future behaviour. While inspection-based bridge management systems provide a useful platform for developing bridge repair and maintenance programmes and associated budgets, they also present some drawbacks. These include high manpower demands, inaccessibility of some critical areas of the bridge during inspections and lack of information on actual in-service loading environment. As a result, some problems related to the structural performance of a bridge may go unnoticed until they become serious or expensive to repair. Shortcomings of inspection-based bridge management systems, developments in signal processing tools, and availability of affordable instrumentation have motivated the development of instrumented monitoring systems. Numerous research efforts on instrumented bridge monitoring systems have been reported in technical papers, e.g. [1–6] to mention just a few. Most of these have focussed on developing methodologies for vibration-based structural identification and damage detection. A detailed review of some structural identification and damage detection techniques is given in [7, 8]. In this paper, attention is paid to the analysis of long-term continuous monitoring of static performance data.

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2. STRUCTURAL HEALTH MONITORING

Structural health monitoring (SHM) is defined here, in the context of a continuous long-term health monitoring system, as the continuous monitoring of a structure's response to the loading environment in order to diagnose the onset of anomalous structural behaviour. This involves continuous measurement of effects such as strains, stress, temperature, humidity and accelerations, due to environmental loading, traffic loading, dead loads and material creep, and the analysis of these data to detect and characterise unusual structural behaviour. The goal of SHM is to complement existing infrastructure management strategies and thus SHM should be viewed as an integral part of an infrastructure management system, Fig. 1.

Typically, a health monitoring system consists of a host computer, sensor excitation hardware, an integrated system of sensors, software and communication hardware. The host computer performs the task of controlling data acquisition and interpretation hardware in addition to storing recorded data in its hard disk, analysing the data, and communicating with remote computers. The sensor excitation and data interpretation hardware provides the link between the sensors and the host computer. This data acquisition hardware excites sensors and converts signals from sensors to appropriate engineering units such as strain, temperature, etc. Sensors are the nerves of the system,

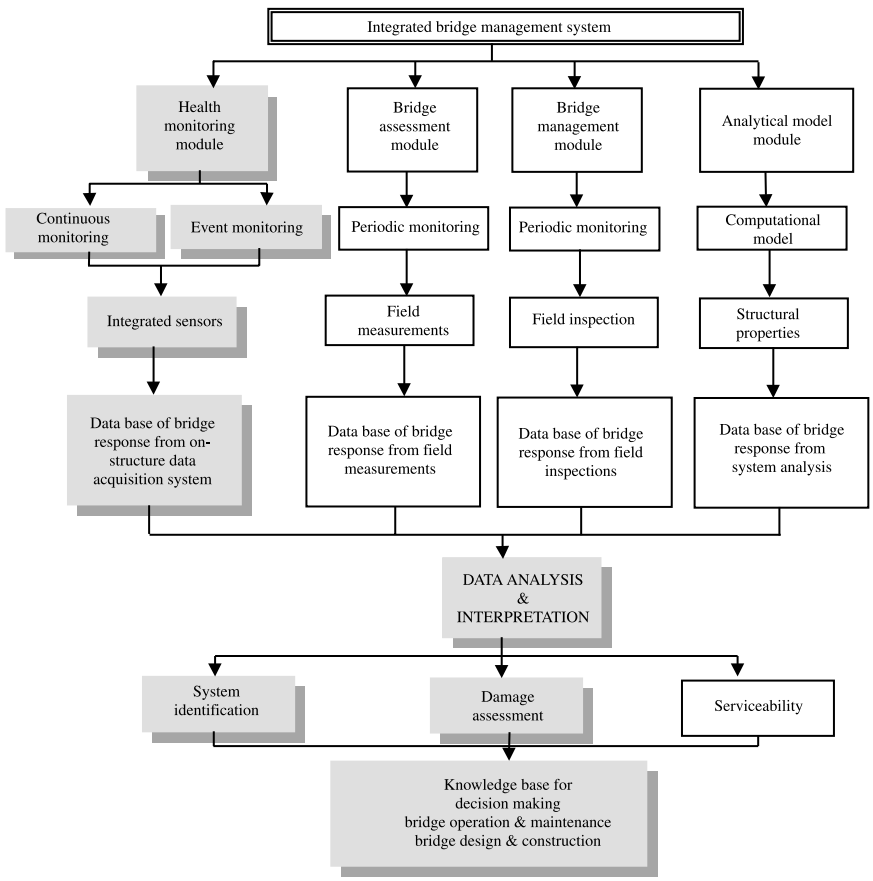

Figure 1. An integrated bridge management system.

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