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Static and Dynamic Properties of Structures measured by Terrestrial Microwave Interferometry

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Abstract

Terrestrial microwave interferometry is a sophisticated technique in geodesy to measure relative displacements of a structure with a high accuracy of up to 0,01 mm at a sampling rate of 200 Hz from a distance of up to 1000 m. One of the big advantages of the method is that the object to be measured does not have to be instrumented or walked-on as the microwaves are reflected by its surfaces and edges. In combination with structural analysis, the in-situ measurements can give a strong support for the condition assessment for a variety of structures in civil engineering and for validating their structural behaviour, robustness and safety. Examples of full-scale measurements of railway bridges and wind turbines will be presented in this paper.

Keywords: Microwave Interferometry, Structural Health Monitoring, Bridge Monitoring

1 Introduction

An important challenge in the field of civil engineering is to develop Structural Health Monitoring (SHM) methods that allow the assessment of the structural behaviour of engineering structures. Over the last two decades, various methods for SHM have been developed. A common experimental method to access the dynamic behaviour of the structure is to test its dynamic properties in operational conditions. The mechanical properties of the structure can also be computed from dynamic parameters like natural frequencies, mode shapes and damping ratios.

Conventional measuring methods use strain gauges or acceleration sensors, whereby the sensors have to be mounted onto the structure. The installation of these sensors is difficult for complex structures or for some inaccessible parts of the structure. Dynamic monitoring for longer periods has not been used very often for SHM due the complexity of the employed instruments.

In this paper, the use of a non-contact, real time deformation measurement system based on microwave interferometry is presented. The main advantage of this technology is its high accuracy, high resolution as well as its ability to detect the overall vibration of the structure that is illuminated by the antenna beam with the identical time stamp. Using the measurements obtained by the sensor, the dynamic properties of the structure can be easily evaluated.

The terrestrial microwave interferometer IBIS (Image By Interferometric Survey), manufactured

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