

Pulse-Pre Pump Brillouin Optical Time Domain Analysis-based method monitoring structural multi-direction strain

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Abstract. The Pulse-Pre Pump Brillouin Optical Time Domain Analysis (PPP-BOTDA) technique is introduced to implement the multi-direction strain measurement. The monitoring principle is stated. The layout scheme of optical fibers is proposed. The temperature compensation formula and its realizing method are given. The experiments, under tensile load, combined bending and tensile load, are implemented to validate the feasibility of the proposed method. It is shown that the PPP-BOTDA technique can be used to discriminate the multi-direction strains with high spatial resolution and precision.

Keywords: multi-direction strain measurement; PPP-BOTDA; distributed optical fiber; experimental study

1. Introduction

The burst of Britain Sheffield reservoir dam caused 254 deaths in 1864. The sudden collision of Canada's Quebec Bridge induced 74 deaths in 1907. There were 12 deaths in the US in Carlsbad, California due to the natural gas pipeline leakage and explosion in 2000. In recent times, several other incidents of bridge/buildings collapse took place in different parts of the world (Brownjohn 2007, Su *et al.* 2015). After these accidents it has become paramount importance of early detection of the health of structures and the sensors must be developed to detect the problem (Ashtankar and Chore 2015). It is an important field which is eagerly needed for an improved future of the major projects and important equipment in many countries. A more advanced monitoring technology is needed whose features are large scale, long-distance, large quantity, high precision, and local small strain monitoring. The important issues are real-time, long-term and effective monitoring, and early warning before a structure suffers disaster.

The implementation of comprehensive structure health monitoring (SHM) in civil infrastructure is made possible by the use of optical fiber sensors and can substantially improve the safety of civil structures and help to manage them more efficiently. The Fiber Bragg Grating (FBG) is a high precision technology which reaches about $3\mu\epsilon$ strain, however it is not truly distributed

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