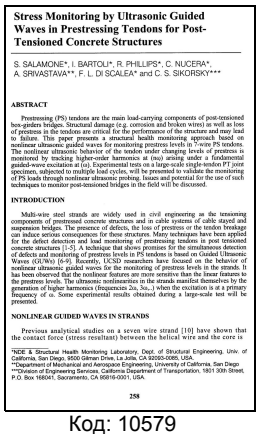
Stress Monitoring by Ultrasonic Guided Waves in Prestressing Tendons for Post-Tensioned Concrete Structures

S. SALAMONE*, I. BARTOLI*, R. PHILLIPS*, C. NUCERA*, A. SRIVASTAVA**, F. L. DI SCALEA* and C. S. SIKORSKY***

ABSTRACT

Prestressing (PS) tendons are the main load-carrying components of post-tensioned box-girders bridges. Structural damage (e.g. corrosion and broken wires) as well as loss of prestress in the tendons are critical for the performance of the structure and may lead to failure. This paper presents a structural health monitoring approach based on nonlinear ultrasonic guided waves for monitoring prestress levels in 7-wire PS tendons. The nonlinear ultrasonic behavior of the tendon under changing levels of prestress is monitored by tracking higher-order harmonics at (nω) arising under a fundamental guided-wave excitation at (ω). Experimental tests on a large-scale single-tendon PT joint specimen, subjected to multiple load cycles, will be presented to validate the monitoring of PS loads through nonlinear ultrasonic probing. Issues and potential for the use of such techniques to monitor post-tensioned bridges in the field will be discussed.

INTRODUCTION

Multi-wire steel strands are widely used in civil engineering as the tensioning components of prestressed concrete structures and in cable systems of cable stayed and suspension bridges. The presence of defects, the loss of prestress or the tendon breakage can induce serious consequences for these structures. Many techniques have been applied for the defect detection and load monitoring of prestressing tendons in post tensioned concrete structures [1-5]. A technique that shows promises for the simultaneous detection of defects and monitoring of prestress levels in PS tendons is based on Guided Ultrasonic Waves (GUWs) [6-9]. Recently, UCSD researchers have focused on the nonlinear behavior of ultrasonic guided waves propagating in multi-wire strands. It has been observed that the nonlinear features are more sensitive than the linear features to the prestress levels. The ultrasonic nonlinearities in the strands manifest themselves by the generation of higher harmonics (frequencies 2ω, 3ω,..) when the excitation is at a primary frequency of ω. Some experimental results obtained during a large-scale test will be presented.

NONLINEAR GUIDED WAVES IN STRANDS

Previous analytical studies on a seven wire strand [10] have shown that the contact force (stress resultant) between the helical wire and the core is

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Код: 10579

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Издательство DEStech Publications, Lancaster, 2010 год

6 стр; формат: 23,5 x 16 см; библиографический список: 13 единиц
ISBN: 978-1-60595-024-2

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Ключевые слова:

Содержание.