Development and Testing of a Friction-Based Post-Installable Sensor for Subsea Fiber-Optic Monitoring Systems

Authors: Nicole Bentley, David Brower, Suy Q. Le, Calvin Seaman, and Henry Tang

This paper presents the design and development of a friction-based coupling device for a fiber-optic monitoring system that can be deployed on existing subsea structures. This paper provides a summary of the design concept, prototype development, prototype performance testing, and design refinements of the device. The results of the laboratory testing of the first prototype performed at the National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC) are included in this paper. Limitations of the initial design were identified and future design improvements were proposed. These new features will enhance the coupling of the device and improve the monitoring system measurement capabilities.

A major challenge of a post-installed instrumentation monitoring system is to ensure adequate coupling between the instruments and the structure of interest for reliable measurements. Friction-based coupling devices have the potential to overcome coupling limitations caused by marine growth and soil contamination on subsea structures, flowlines or risers. The work described in this paper investigates the design of a friction-based coupling device (friction clamp), which is applicable for pipelines and structures that are suspended in the water column and those that are resting on the seabed. The monitoring elements consist of fiber-optic sensors that are bonded to a metal clamshell with a high-friction coating. The friction clamp has a single hinge design to facilitate the operation of the clamp and dual rows of opposing fasteners to distribute the clamping force on the structure. The friction clamp can be installed by divers in shallow depths or by remotely operated vehicles in deep-water applications. NASA-JSC was involved in the selection and testing of the friction coating, and in the design and testing of the prototype clamp device. Four-inch diameter and eight-inch diameter sub-scale friction clamp prototypes were built and tested to evaluate the strain measuring capabilities of the design under different loading scenarios. The testing revealed some limitations of the initial design concept, and subsequent refinements were explored to improve the measurement performance of the system.

This study was part of a collaboration between NASA-JSC and Astro Technology, Inc. within a study called Clear Gulf. The primary objective of the Clear Gulf study is to develop advanced instrumentation technologies that will improve operational safety and reduce the risk of hydrocarbon spillage. NASA provided unique insights, expansive test facilities, and technical expertise to advance these technologies that would benefit the environment, the public, and commercial industries.