OTC 18276

The Effectiveness of Helical Strakes in the Suppression of High-Mode-Number VIV

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This paper was prepared for presentation at the 2006 Offshore Technology Conference held in Houston, Texas, U.S.A., 1–4 May 2006.

Abstract

Triple helical strakes can play an important role in the suppression of VIV on offshore platforms. This paper will present results of two field experiments, one conducted at Lake Seneca in upstate New York and the second in the Gulf Stream near Miami, Florida. Three different distributions of triple helical strakes were tested. These experiments were designed to explore the effects of VIV on both bare pipes and pipes with strakes at mode numbers greater than the tenth mode in uniform and sheared currents. At Lake Seneca, bare pipe and full strake coverage pipes were tested in uniform currents. In the Gulf Stream two different configurations of strakes were tested and compared to the VIV response of a bare cylinder. The two configurations are referred to as the 40% coverage case and the 70% staggered coverage configuration. The results of these tests showed a reduction in the amplitude of the vibration and also the frequency content of the vibrations. In particular, a large third harmonic component, which contributes significantly to the fatigue damage rate, was suppressed by the configurations with strakes. Together these reductions will greatly increase the fatigue life of the pipe.

Introduction

The tests at Lake Seneca were conducted in the summer of 2004 and focused on the measurement of VIV in uniform flow at high mode number for a bare pipe and for the same pipe with complete strake coverage. In comparison, the Gulf Stream tests were conducted in October and November of 2004 and focused on bare pipe and partial strake coverage with sheared flow. Both tests are part of a larger VIV testing program developed by DEEPSTAR (A joint industry technology development project).

As oil exploration and drilling moves into deeper water, understanding the dynamics of long pipes, vibrating at high mode numbers in sheared currents, becomes important. Additionally, understanding how strakes affect the dynamics of bare pipe is also important. The main objectives of the Gulf Stream Test were:

- To gather vortex-induced vibration response data using a densely instrumented circular pipe at high mode number,
- To measure mean drag coefficients (C_D) at high mode numbers and improve drag coefficient prediction formulas,
- To test the efficacy of helical strakes at high mode numbers,
- To obtain statistics on the distribution of single-mode vs. multi-mode response to VIV,
- To determine the relative contribution to damage rate, arising from in-line and cross-flow VIV,
- To improve knowledge of damping factors on risers equipped with helical strakes.

Gulf Stream Test Description

The Gulf Stream tests were conducted on the Research Vessel F. G. Walton Smith, operated by the University of Miami. The composite pipe was 485.3 feet long and 1.4 inches in diameter. The pipe was instrumented with fiber optic strain gauges to monitor the vibration.

The pipe was spooled on a drum that was mounted on the aft portion of the boat. The pipe was un-spooled and lowered into the water using a hydraulic motor. At the bottom end was a railroad wheel assembly which included a current meter, a center spool and U-joint. The assembly weighed 836 lbs in air and approximately 725 lbs in water, and was attached to the bottom of the pipe to provide tension. The weight in water of the pipe was 0.12 lb/ft. With additional drag forces on the pipe the typical total top end tension was 820 lb. The pipe was attached to the stern of the boat on a perch. About six feet of pipe were above the waterline. A variety of current profiles with significant variation in speed and direction were achieved by steering the vessel at numerous headings, while in the Gulf Stream.

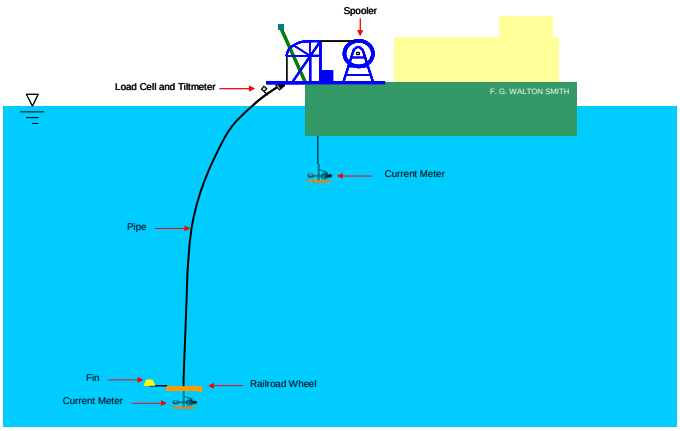

Figure 1 – Experiment Set-up for the Gulf Stream Test