



OTC 17533

Development of SHEAR 7 Lift Curves for VIV Analysis and Application to Single Pipe and Bundle Risers

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Abstract

In late 2003 BP contracted 2H to manage and run a series of forced oscillation tests at the Marin test basin, Netherlands. The tests examined the effect of vortex induced vibration (VIV) and galloping response on a full size section model of a single pipe riser and a non-symmetric riser bundle. The tests used a 200mm diameter pipe at a Reynolds number of 39,600.

This paper presents the results (lift and added mass coefficient with increasing amplitude and reduced velocity) from the single pipe forced oscillation tests. A method is developed to convert the test data into parabolic lift curves and damping coefficients for Shear7 VIV analysis. The parabolic lift curves created from the single pipe forced oscillation test data are shown. The method is then extended for use with the test data from the non-symmetric riser bundle forced oscillation tests, and accounts for differences in peak reduced velocity in the test data by calculating effective vortex shedding diameters.

Sensitivity analysis is conducted using the parabolic lift curves with Shear7 on an example deepwater riser. This shows that the fatigue lives predicted using the parabolic lift curves are generally lower than the default Shear7 lift curves.

Introduction

Forced oscillation VIV tests on a 200mm diameter single rough pipe were conducted using the MARIN forced oscillation test rig. Further tests were conducted using a non-symmetric riser bundle. 2H Offshore worked with BP and MARIN to establish a strategy for both single pipe and the non-symmetric riser bundle tests. 2H managed the tests for BP and provided post analysis.

The objectives of this paper is to present:

- Lift coefficients obtained from the large scale single rough pipe tests
- Parabolic lift curves created from the single rough pipe test data.
- The method used to convert test data into lift curves accounting for the non-symmetric riser bundle.
- Sensitivity of VIV fatigue life to the different lift curves.

Further tests using the single pipe at a range of critical and trans-critical Reynolds numbers with and without the rough coating were conducted. These are not detailed in this paper.

In this paper the term 'lift coefficient' refers to the lift coefficient in phase with velocity, $C_{L,V}$, which indicates the flow induced lift (vortex induced lift) as opposed to the lift coefficient in phase with acceleration.

Forced Oscillation Tests for VIV Forces

Forced Oscillation Test Rig

The tests were conducted using a 200mm diameter x 3.4m long aluminium pipe that was artificially roughened by coating the pipe with 500 micron sand grains. The roughness is greater than may be seen on real risers, but was chosen to provide a definite rough pipe benchmark. Moreover ocean conditions would be more turbulent than would be the case in the tank, and the higher roughness would make up for this by forcing laminar-turbulent boundary layer transition.

The test rig used was able to test in both forwards and reverse directions at speeds of up to 2m/s. The single rough pipe tests presented here were conducted using a tow speed of 0.22m/s. The Reynolds Number was 39,600, which is sub-critical.

The pipe was actuated vertically on linear bearings using a crank shaft connected to a high power motor which allowed the rotation rate, and hence frequency of oscillations to be controlled accurately. A picture of the test rig is given in Figure 1. Further details of the test apparatus have been presented by de Wilde *et al* (2004) [6].

The test rig provides a single degree of freedom oscillatory motion perpendicular to the tow direction. This motion is

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