Advanced Pipeline Crossing Analysis
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ABSTRACT

In the Arabian Gulf Region the design and construction of pipeline crossings poses a number of challenges due to the shallow water conditions. Typical examples are on-bottom hydrodynamic stability and Vortex Induced Vibration (VIV). For both of these design aspects, there are no specific design criteria or methodology dealing with crossings as is the case for pipelines resting on the seabed. Consequently, the industry relies on interpretations of existing codes which do not capture the particularities of a crossing. This paper addresses crossing VIV and demonstrates that, in the presence of axial compressive loads, advanced analyses are required for an assessment of the crossing behavior and possible optimized crossing design.

KEY WORDS: Crossing; Free span; VIV; Pipeline; Crosswalking; Subsea

INTRODUCTION

A number of fields are developed in phases which span many years and this phased development can include a large number of pipeline crossings. For each crossing, sleepers are installed on both sides of the existing pipeline to achieve a minimum clearance of 300mm between the new and existing pipeline. The number of crossings and sleepers can be large and in one particular UAE offshore project, one phase of the development included more than 400 crossings and required the installation of some 3000 sleepers. Sleepers are made of precast concrete and have a width which can range from 6m to 10m to accommodate installation tolerances and in-service loads. Typical sleepers are shown in Fig. 1. These sleepers will be pre-installed along the pipeline route and have different heights to ensure a profile which will not overstress the pipe. The sleepers’ will be installed at a spacing defined according to the calculated span length. The sleepers will graduate in height from the extremities near the touchdown region to the center of the crossing. Generally, the pipeline will be laid flat on top of the sleepers as shown in Fig. 2 provided that the frictional resistance exceeds the hydrodynamic loads. If this is not the case, the pipeline will be tied to the sleeper using chain assembly, clamps or restraining blocks.

Under operating conditions pipelines develop compressive axial loads due to temperature and pressure effects. This is because the expansion of the pipelines is restrained by the seabed frictional resistance. These axial loads are significant and exceed hundreds of tons for most pipelines under typical operating temperatures and pressures.

In the presence of compressive axial loads, a particular challenge for the design of crossings is that the allowable span lengths tend to be too short. This, together with tolerances in the seabed bathymetric survey,