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Vessel Motion Based Laying Criteria for Rigid and Flexible Pipes in Deepwater

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ABSTRACT

The traditionally used lay criteria for the installation of rigid and flexible pipes as well as umbilicals based on environmental characteristics are often used with difficulty and inaccuracy.
It has been shown that in deepwater, the behavior of the bottom part of a catenary (minimum bend radius, minimum and maximum axial load) is very well correlated to the heave velocity of the vessel at the location of the hang-off point. In addition, the top tension is well correlated to the heave acceleration at this point. The paper describes how the latter has been demonstrated and the lay criteria determined, as well as the method used to apply it during installation operations. Several softwares are used onboard: one is for statistical analyses of motion measurements of a MRU (Motion Recording Unit); another one is a vessel motion predictor software that compares calculated motions for present and forecasted weather conditions. The lay parameters and criteria further depend on the measured current profile which is also used to predict the top angle,

KEY WORDS: laying, criteria, installation, heave velocity

INTRODUCTION

The lay criteria for the installation of rigid and flexible pipes as well as umbilicals are traditionally under the form of maximum significant height with sometimes, the addition of wave period range and maximum current velocity. This criteria is often difficult to use because first the evaluation of the actual sea state characteristics are not easy (weather forecast are not always accurate) and secondly, it is impossible to formulate in the case of multidirectional seas and multi-peak wave spectra, as often found offshore Brazil or West Africa.
The attempt to use more simple criteria based on the vessel motion has been made for the preparation of the installation of flexible flowlines and umbilicals and associated risers in deep water (1000m to 1300m water depth) offshore Brazil. Vessel motion based criteria are proposed below for deep water normal laying. This follows the work done by Standing (2005) and Cocault-Duverger (2007).

LAY PARAMETERS OF IMPORTANCE

Catenary configuration (lay-back distance)

The catenary configuration is controlled by monitoring the projection on the lay route of the horizontal distance between the flexible or umbilical hang-off point on the lay vessel and the touch down point (TDP). We are considering the average distance because the TDP and vessel position vary due to the wave induced vessel motion. The information is obtained in real time by an ROV that monitors the average position of the TDP during laying, using the positioning system used on the field. The lay parameter is a "static" (i.e. average) nominal lay-back distance and a plus and minus tolerance on this distance, thus defining an allowable lay-back range.

Top tension

For flexible installation, the top tension is measured to check that it is not getting flooded accidentally (for umbilical it is not strictly needed). But this measurement cannot be used to control the catenary configuration.

Effects of current

An Acoustic Doppler Current Profiler (ADCP) instrument mounted on an ROV is used to measure the current velocity and direction. The ROV has to be moved over the whole water column to obtain a complete current profile. A time trace of the current velocity measured offshore Brazil, at different elevations during a period of time with large current is shown on fig 1. There are significant variations due to tide (half day period), even at great water depth. There are also rapid velocity changes. It is then recommended to measure the current at least every 3hr in case of delicate installation operations.
The current may impose limitations because of the following effects (non exhaustive list):
- increase of the average top angle and then risk of exceeding the angle limit of the bellmouth (tulip). The top angle due to current is predicted from the measured current profile. A maximum allowable roll/pitch combined angle is deduced.
- Tendency of the catenary to become unstable when the current is flowing against the direction of the lay route. Consequently, the specified layback is increased in case of strong current in this direction.
- Decrease of the MBR, increase of the maximum compression and