Impact of Reel-Laying on Mechanical Pipeline Properties
Investigated by Full- and Small-Scale Reeling Simulations

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ABSTRACT

Reel-laying is a fast and cost-effective method to install offshore pipelines. During reel-laying repeated plastic strain is introduced into the pipeline which may, in combination with ageing, affect strength and ductility of the pipe material. The effect of reel-laying on the pipe material is simulated by small- or full-scale reeling simulations followed by mechanical testing according to corresponding standards. In this report an appropriate test setup for full-scale reeling simulation is presented. The fitness-for-use of the test rig is demonstrated by finite element calculations as well as by full-scale reeling simulations on different pipes of various grades. Moreover, small-scale reeling simulations with subsequent ageing and mechanical testing are performed on the same pipe material. A comparison of results from mechanical tests after small- and full-scale reeling simulations is given. Additionally results from collapse tests on pipes after full-scale reeling simulation are presented and the influence of repeated bending of the pipe on its collapse behavior is discussed.

KEY WORDS: reel laying; offshore pipeline; reeling simulation; finite element analysis; mechanical properties; collapse

INTRODUCTION

Two main concepts are normally used for laying offshore subsea pipelines. In the S- and J-lay method a pipeline is fabricated on the deck of a lay barge by welding together individual lengths of pipe as the pipe is paid out from the barge. The pay-out operation must be interrupted periodically to permit new lengths of pipe to be welded to the string. The S- and J-lay method requires that skilled welders and their relatively bulky equipment accompany the pipelaying barge crew during the entire laying operation; all welding must be carried out on board and often under adverse weather conditions. Further, the S- and J-lay method is relatively slow, with experienced crews being able to lay only few miles of pipe a day. This makes the entire operation subject to weather conditions which can cause substantial delays and make working conditions quite harsh.

The other principal conventional concept is the reel pipelaying technique. In this method, a pipeline is wound on the hub of a reel mounted on the deck of a lay barge or a vessel. The pipeline is generally spooled onto the reel at a shore base. There single pipes can be welded under protected and controlled conditions to form a continuous pipeline which is spooled onto the reel.

Fig. 1: Reel-laying vessel during operation

At the offshore pipelaying location the pipeline is spooled off the reel between completion points (Fig. 1). This method has a number of advantages over the S- and J-lay method, among them speed (one to two miles per hour), lower operating costs (e.g. smaller welding crews and less welding equipment must be carried on the lay barge), and less weather dependency (Recalde, 1990).

Reel-laying introduces reverse plastic strain into the pipe during reeling on and off, aligning and straightening, and may thereby modify pipe properties. During reeling onto the drum plastification of each pipe welded into the line is not uniform. The first layer is aligned with the drum radius. With each layer reeled onto the drum, the radius increases by size of pipe diameter. In the aligning stage the entire pipe is bent to