Mechanical Properties after Full-Scale Reeling Simulation of X65 Equivalent Grade Seamless Pipe

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ABSTRACT

There are several methods for laying offshore oil and gas pipeline. The reel-lay process is fast and one of the most effective offshore pipeline installation methods for pipes with outside diameter of 16 inches or less. In the case of the reel-laying method, line pipes are subjected to plastic deformation multiply during reel-laying. Full scale reeling (FSR) simulations were performed to investigate the effect of the cyclic deformation on the mechanical properties of the line pipe. In the FSR simulations, the influences of the bending radius and repeated times of multiple plastic deformation were investigated.

KEY WORDS: reel-laying; reeling simulation; offshore pipeline; seamless pipe; cyclic deformation; mechanical properties; full scale

INTRODUCTION

There are mainly three methods, which are S-lay, J-lay and Reel-lay, for laying method of offshore pipeline. In case of S-lay, pipes are laid horizontally on the vessel. Girth welding, inspection of welded portion, coating and so on are performed continuously and simultaneously at several stations. Connected pipes are laid down on the seabed. Laying speed is comparatively fast. On the other hand, many operators are needed for this method because several operations (which are girth welding, inspection, coating and so on) are performed on the vessel. This method is named S-lay because pipeline shape during laying looks like the letter “S”. In a deep water area, there is a concern of buckling because the shape like “S” of pipeline during laying becomes steeper. J-lay is an offshore installation method that one pipe or a few pipes, which are connected by girth welding, are stood vertically and then are connected to pipeline by girth welding. Connected pipes are installed in the sea vertically and laid down on the sea bed. Many operations can be performed continuously and simultaneously while pipes are laid horizontally. However, there is only one station for girth welding, inspection, coating after standing the pipes vertically. Therefore, laying speed is very slow.

Reeling is an installation method when pipes are welded on land, it is reeled around a drum, and on a reel-laying vessel, and reeled off at the construction point. The welding in the laying vessel is basically unnecessary, and therefore, the laying speed is remarkably fast compared with S-lay and J-lay. The number of workers in the laying vessel can be minimized because welding in the laying vessel, whereas there is a large fixed cost of a vast yard for the welding on land. Moreover, it is limited to the size of the pipe that can be reeled around the drum, and application to large diameters is a difficult method. The feature in construction of each installation method is shown in the above mentioned. Reeling is an installation method which effects the mechanical properties of the pipe. Pipes will be bent and straightened several times during reeled-around-drum and then installed in the sea. At the time of bending the pipe, the compression strain is given on the intrados and the tension strain is given on the extrados. It is expected that the mechanical properties of cyclic deformed pipe will change. Mechanical properties, after reeling simulation, have been investigated and reported (Anelli, Tivelli, Izuquierdo and Quintanilla, 2006; Meissner, Erdelen-Peppler and Schmidt, 2009) in international technical reports. In the DNV OS-F101, two test methods for the confirmation of the mechanical properties of cyclic deformed pipe are specified as additional requirement SR-P. One is a method to confirm mechanical properties after FSR simulation. Another is a method to confirm mechanical properties after Small Scale Reeling (SSR) simulation that gives cyclic deformation to specimens, which are extracted from the pipe.

FULL SCALE REELING SIMULATION

Test Material

Seamless pipe as a follow were applied for FSR simulation, X65 equivalent Outside Diameter (OD) 323.9mm x Wall Thickness (WT) 19.1mm

Simulation

FSR simulations were carried out by bending and straightening full scale pipe cyclically at a laboratory in UK, Exova. First, pipes are set between strainer and straightener. After that, pipes are bended and straightened using the following process. First step, pipes are bended...