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Three dimensional finite element analysis of 4 inch smart flange on offshore pipeline

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Abstract. Smart flanges are used for pipeline and riser repair in subsea. In a typical case in the gas export pipeline project, the end cap bolts of a 4inch smart flange were broken during operation, and in turn leakage occurred. This work presents the detail of three dimensional finite element analysis of the smart flange to support the observed end cap bolts failure. From finite element analysis it turns out that in the presence of external bending moment, an uneven contact distribution is present between seal and end cap, which in turn changes the uniform load distribution on bolts and threaten the integrity of bolts. On the other hand, 3D finite element analysis of interaction between pipeline and seabed is presented by means of Abaqus to explore the distribution of bending moment along the pipeline route. It is found that lateral buckling occurs in the pipeline which introduces large bending moment.

Keywords: smart flanges; subsea pipeline; end cap bolts; seabed topography; 3D finite element

1. Introduction

In shallow water offshore, the natural gas from wellhead jackets is transferred to onshore plant through export pipeline of different sizes, 24, 30, 32 inch. Export pipelines each with a piggy back line are used to transport raw material to onshore facilities. Due to presence of corrosive environment in sour services and probability of hydrate formation in the pipeline, mono-ethylene glycol (MEG) is introduced in the pipeline from offshore side. MEG is provided from onshore facility and exported to jacket through a 4inch line, piggy back line, which is secured to mainline through strapping (Yong 2001). In case of 3rd party activities such as trawl gear interference and anchoring, the 4inch line may be damaged and de-strapped from mainline (DNV-OS-F101, DNV-RP-F110) If any rupture in piggy back line is happened, emergence activity is required to correct the pipeline. In the meanwhile, MEG is transported to offshore facility through ships, which is too expensive. Consequently a fast remedial action is required. Among different techniques to mitigate the damaged section of pipeline, using smart flange is fast and applicable approach which is of interest for offshore industry. The product offers pipeline and riser repairs without the need for hyperbaric welding and can be installed in driverless applications. Available worldwide, the end connectors are stocked in a variety of sizes to accommodate from 2 inch up to

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