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A study on the behavior and strain concentration in offshore steel pipeline with concrete coating under combined loads using Finite Element Analysis

Pooya Kheiri, Moharram Dolatshahi
University of Tehran, Tehran, Iran
University of Tehran, Tehran, Iran

pooya.kheiri@ut.ac.ir

mdolat@ut.ac.ir

Abstract

It is surely important for offshore pipeline industries to reach accurate and reliable modeling of the strains in concrete coated pipelines. It should be noted that because of the ability of concrete coating in bearing compressive strains, there are huge strains in steel at **field joints** (FJ). Most pipelines consist of approximately 12m long welded joints. The body of each joint is covered by a corrosion coating, often asphalt, and a concrete cover for weight and protection purposes. However, approximately 35cm at each end remains uncover to allow welding at field joints. In the past, pipelines were designed using stress based criteria. Deeper waters and also new techniques for installing impose very large strains and lead to uneconomic designs, so it is important to use **strain base design (**SBD), which was developed during nineties. SBD takes advantage of the plastic deformation ability of steel. In the current practice, a new approach is presented to consider the tension which is imposed at tensioner along with bending that occur in stinger, with an accurate **finite element** (FE) method, which has not be done previously. In this paper a framework for finite element modeling of concrete coated pipelines is presented and has been verified with the test results available in literature. It should be noted that, no laboratory tests data are available for the collapse behavior of huge concrete coated pipes caused by **combined** tension and bending loads, however impact of tension loads can be measured by comparing the results of bending tests with current practice results. All of abovementioned aspects are described and modeled appropriately using FE software "ABAQUS", regarding modeling of three concrete, steel and ACL layers with appropriate meshes and concrete sliding towards the FJ and concrete cracking and crushing, the results can be reliable and applicable.

Keywords: Offshore Pipelines, Strain concentration, Finite Element, Combined Loading

1. INTRODUCTION

Strain Based Design (SBD) is an accepted and novel design philosoghy used for offshore pipelines. With this method designer can safely utilizes the plastic deformation and it has been used for several pipelines from nineteenth.

Ever since the first pipeline was installed offshore pipe development has been moving into ever deeper waters. While in the early days of the of the offshore industry 100m water depth was considered as deep, nowadays pipelines are being installed in 2000m water depth or more. Until now, the deepest pipeline project that has benn executed was the Bluestream project with a maximum depth of 2,150m in 1994. So whatever the depth of water increase leads to making loads critical and merit of SBD is indispensible.

According to the literature, the research on this topic up to now can be classified as experimental investigations, semi – analytical formulations and FE simulations. In this paper the result from experimental analysis of Ness and verily are utilized and validated against FE results of current investigation.