UNIVERSITI TEKNOLOGI MARA

ARTIFICIAL NEURAL NETWORKS FOR BURST PRESSURE STRENGTH OF CORRODED SUBSEA PIPELINES REPAIRED WITH COMPOSITE FIBER-REINFORCED POLYMER PATCHES

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ABSTRACT

The application of Composite Fiber-Reinforced Polymer (FRP) patches for rehabilitating corroded subsea pipelines is a burgeoning field in offshore technology. However, the current finite element analysis-based modeling is time-consuming and lacks comprehensive defect coverage. This underscores the rising demand to explore predictive models for subsea pipeline repair, particularly in the oil and gas sector, to ensure sustained and stable operations. Developing an effective prediction model that utilizes Artificial Neural Networks (ANN) to correlate with the repaired assessment method, particularly composite FRP, can potentially overcome these limitations. Hence, this study aimed to present an effective method to evaluate the strength of repaired subsea pipelines to sustain burst pressure loads and determine the suitability of Composite FRP repaired assessment to multi-level corrosion in subsea pipelines using the finite element analysis and ANN modeling. The research methodology unfolds in three pivotal phases. Phase 1 is dedicated to the meticulous analysis of historical data, employing statistical techniques that align with relevant offshore codes. Phase 2 shifts the focus towards finite element modeling, providing deep insights into structural behavior. Finally, Phase 3 marks the development of an influential ANN prediction model, leveraging essential input data. The efficacy of the suggested method was demonstrated by comparing the output of the ANN with the historical FE output. A computational model for predicting the burst pressure strength of repaired pipelines with composite FRP patches was employed using the ANN algorithm. The geometry of corrosion damage was defined by three physical parameters, namely length, width, and depth. Finally, the computational model was validated by comparing the results with refined FE method solutions. Based on the results, it was observed that the composite repaired material study was ineffective when the predicted burst pressure decreased after the repaired analysis was carried out. In contrast, composite FRP repaired method was effective for defect sizes greater than 50 mm x 50 mm at any level of corrosion. Furthermore, the published ANN models were able to predict the burst pressure of the corroded and repaired subsea pipelines. In short, the proposed method was considered useful for developing a quick procedure for the composite FRP based repair scheme of corroded subsea pipelines.

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CHAPTER ONE
INTRODUCTION

1.1 Overview

The strength capacity of metallic pipes is diminished by corrosion, but leakage in composite pipelines is caused by matrix cracking and abrasion. Both corrosion and abrasion have a notable impact on pipeline systems, resulting in substantial losses and a reduction in their structural integrity. There are two classifications for corrosion that occurs in metallic pipelines. There exist both exterior and interior forms of corrosion. Almost every aspect of the world's infrastructure is affected by corrosion, from structure to serviceability system infrastructures, including water and wastewater systems, chemical processing, as well as oil and gas (Lieser et al., 2010). Corrosion consists of several types, each of which can lead to structural defects or interact with each other to cause minor or major failure (X. Li et al., 2016). This failure can cause a critical incident that affects primary services of pipelines, such as the explosion of a gas pipeline at Bukit Beriwan, Lawas Sabah, in 2014 has made significant news in the offshore industry (Borneo, 2014). Even though no injury was reported, it has major consequences on the repair cost and service continuity. Damaging of pipelines, as shown in Figure 1.1 (Meruonline, 2023), and major incidents can cause corrosion disrupts operations and requires extensive repair, worker fatalities, severe threats and damages to public safety, as well as replacement of failed assets.

Figure 1.1: Corrosion defects of subsea pipelines (Meruonline, 2023)