Abstract

The rapid growth of industries has led to a rise in oil and gas pipelines. In the transmission pipeline industries, some parts of high-pressure pipelines, especially those that have long been in service, might undergo corrosion. Moreover, economic and environmental factors as well as human life have caused the pipeline failure to be recognized as an important issue in structural safety. Therefore, accurate predictions of failure pressure for corroded pipelines are of vital for importance in engineering design process and assessment safety levels for pipelines. In the present study, attempts are made to investigate the failure pressure in corroded pipelines based on finite element analysis using nonlinear material behavior by Ramberg-Osgood model at three different yield strains (1, 0.5%, and 0.2%). The accuracy of finite element modeling for 40-actual laboratory data test evaluate and compared by empirical model for with a variety of different pipelines made by X60, X65, X80 and X100 steel grades. In the finite element model, corrosion defects are given as to be elliptical from. The results show that finite element models are more accurate than empirical relations, and the best nonlinear failure pressure modeling of corroded pipelines was obtained using the Ramberg-Osgood model with yield strain of 0.2%. This finite element model using to simulate 408-data of corroded pipes with mid-high grades by randomly defects levels in order to train the artificial neural network. 40 laboratory data were used to test ANN. The ANN was structured using input variables such as geometrical properties of the pipeline (diameter and thickness), geometrical properties of corrosion defects (length, width and depth) and steel material properties (yield and ultimate strength). The best ANN structure was obtained using the CGP algorithm for training with and 17 hidden layers. The training and testing results of ANN were compared to several empirical models according to comparative. including root-mean-square error (RSME), mean absolute error, (MAE), the Willmott index of agreement (d), and the Nash–Sutcliffe efficiency (NSE). ANN estimations provides the accurate results for both test and training parts then other models. The ANN in train and test data showed the best correlation between FEM-based prediction data (R^2=0.99 and 0.984 respectively). Thus, finite element methods based on Ramberg-Osgood model with 0.2% yield strain and the ANN were proved to be suitable tools for estimating the failure pressure in corroded pipelines. by increasng the $\frac{L}{\sqrt{Dt}}$ and $\frac{d}{t}$ ratios, it is obtained the failure pressure of corroded pipelines are decreased.

Key words:

Failure pressure, Finite element method, Ramberg-Osgood model, corroded pipelines, Multilayer neural network

University of Zabol
Graduate school
Faculty of Engineering
Department of Civil Enginering

The Thesis Submitted for the Degree of M.Sc (in the field of Civil Engineering-Structure Engineering)

Prediction of failure pressure for corroded pipelines using multilayer neural network and finite element model

Supervisor
Dr. B. Keshtegar

Advisor
Dr. M. R. Hosseini Tabatabaei

By
M. A. Shahraki Nader

Autumn 2018