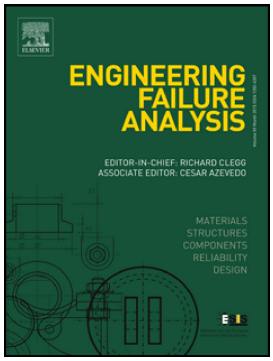

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Failure analysis of the floating pipeline with defect under flooding load

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Abstract

Crossing pipelines buried under the rivers will be easy to float in a flood. The impact of floods on the exposed pipes can cause significant bending deformation and even rupture. Furthermore, pipelines with defects are more prone to failure, resulting in serious environmental disasters. This paper is focused on the fracture failure of the floating pipe. A mechanical model of the free spanning pipeline in a flood including nonlinear interaction between the pipeline and soil was built. The distribution of stress and displacement of the floating pipeline was studied by nonlinear FE method. Dangerous sections of the floating pipeline were obtained. Pipelines contain defects because of corrosion and mechanical damage. The allowable critical dimension of the defect is proposed for the safety assessment of floating pipes with defects, local finite element models of pipelines with defects were established under the combined effect of internal pressure, bending moments and axial force which can be obtained from the pipe-soil coupling mechanical model. Based on the method of plastic limit, Python was used to modify the dimensions of the volumetric defect to obtain the allowable critical dimension under the given condition by example of API X70 φ1016. This may provide more convenient reference for the safety assessment of pipelines with defects in practical engineering. The paper also analyzed the influence factors of pipeline stress and the critical dimension, such as the spanning length, crossing angle of pipeline, the velocity of flood flow.

Key words: flood; pipeline; failure; nonlinear; mechanical analysis; finite element; defect; allowable critical dimension

1. Introduction

In the past 30 years, floods caused by heavy rain or other disasters have been a great threat to the safe operation of pipelines. With the scouring effect of a flood, oil and gas pipelines often float locally. Because the loads on exposed pipes are large, they cause the bending deformation of pipeline and parts of the pipelines rupture due to the strong impact of floods, which leads to serious environmental consequences, especially for gas pipelines crossing river laid by the traditional excavation method. Pipeline failures occurred in recent years because of flood are listed in Table 1[1-3].

Figure 1. Lanzhou-Chengdu-Chongqing Products Pipeline floating owing to the flood scouring

For the impact of flood on the floating pipe, numerical simulation of the spanning pipeline under the flood load was done by