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Mechanical behaviour of PowerSeal Saddle for service line

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1 INTRODUCTION

The saddle plays an important role in providing robust, reliable service line connections between water mains and customers. Nowadays, there are lots of different types^[1] of service saddles used in industry for service line installation, while the slippage or damage of saddle caused by earthquake-induced underground movement leading to severe water leakage have always been widely observed. Therefore, Powerseal Pipeline Products Corporation developed a new saddle called Powerseal Saddle^[2] aiming to risk such engineering risks.

This paper describes the mechanical behaviour of Powerseal Saddle on both experimental tests and numerical simulations to evaluate the slippage or failure mode of the buried saddle and pipeline subjected to the monotonic shear loading.

2 METHODOLOGY

The experimental setup was developed at the Center for Smart Infrastructure (CSI) of UC Berkeley. Unlike conventional strain gauges deployed at discrete locations of the pipeline, novel fiber optic sensing technology is used to obtain distributed continuous strain measurement of the saddle and pipe. Besides, in order to evaluate the whole mechanical response of the saddle and pipeline, a three-dimensional (3D) finite element (FE) model is conducted.

2.1 Overview of the lab test

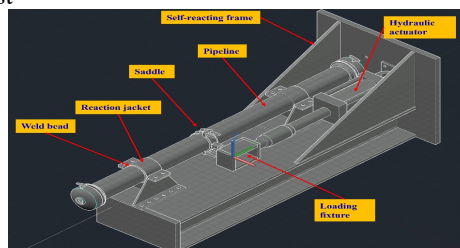


Figure 1: Experimental setup

2.2 Overview of the FE model

The FE models were conducted using ABAQUS software. The model geometry and material of the pipe and joint was based upon the experiments. FE meshes used for the analysis are shown in Fig. 2 . The isotropic 3D solid continuum element (C3D8R) is used to model the saddle and pipe.

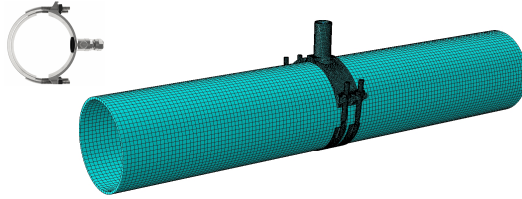


Figure 2: FE model mesh

In particular, the rubber interface between saddle and pipe is modelled using a series of spring elements to save computation cost without compromising accuracy. The spring stiffnesses in both normal and tangential were calculated based on the properties of the NBR rubber used for the Powerseal saddle.

3 RESULTS & DISCUSSIONS

3.1 Comparison of FO data & FE results

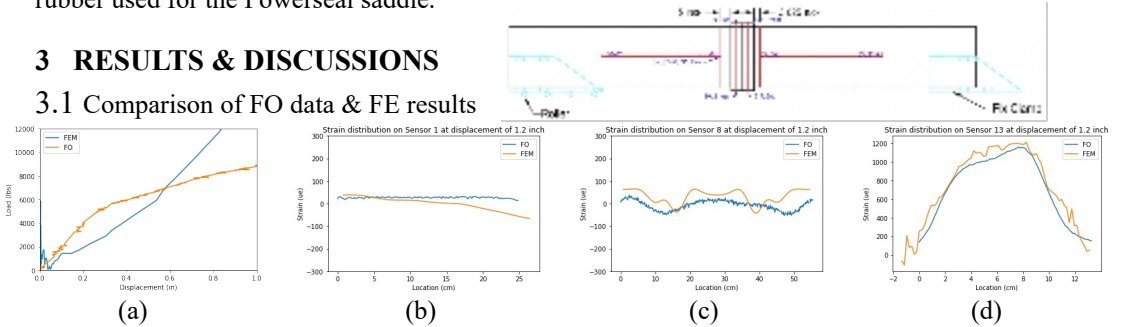


Figure 3: (a) Load VS displacement ; (b) sensor 1; (c) sensor 8; (d) sensor 13

Fig 3 shows that the FE simulation results show agreement with experimental data of the saddle and pipeline behaviour in the lab test. DFOS Sensor 1 and Sensor 2 show the continuous longitudinal strain and circumferential strain along the pipeline near the saddle section, respectively, indicating that the pipe squated in the transverse cross-sectional plane. Sensor 3 shows the circumferential tension strain along the saddle strap, as expected in the FE model.

4 CONCLUSIONS

DFOS data together with the FE models reveal 3D continuous pipe & saddle deformation profile during the loading test. Compared to conventional saddles, the Powerseal saddle shows a better extension capacity and superior resilience to minimise water leakage.

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