PII Pipeline Solutions
a GE Oil & Gas and Al Shaheen joint venture

Seeing more detail through the invisible clues of strain

PII's proven Strain Assessment experience provides significant integrity and cost advantages

Challenge

Inertial Mapping Units (IMUs) are commonly included in in-line inspections (ILIs) to generate XYZ coordinates for precise location of identified features, anomalies and fittings. A less common use of IMU data is to track any deviation of the pipeline from its original position, which is a cause of pipeline bending strain.

Determining an acceptable limit for bending strain is not a straight-forward exercise. Pipeline industry experiments have obtained a wide range of tensile strain capacities, and it is a challenge to determine standard strain acceptability limits from industry guidance. In cases where strain is coincident with other pipeline defects, the tensile strain capacity of the line may be further affected. Assessment in these cases often require further in-depth analysis.

PII has built up significant experience in deriving pipeline bending strain levels from measured curvature data. Our approach of combining strain data with information from other ILI tools has proven to deliver powerful results—providing better characterization and early warning of threats to pipeline integrity.

CHALLENGE

Bending strain can affect pipelines located in many different environments, and it often goes undetected. Definition of strain limits is an ongoing industry challenge.

SOLUTION

PII has developed a strain assessment methodology based on extensive in field and analysis experience. We continue collaborating with pipeline operators around the world to strengthen the industry s knowledge base.

BENEFITS

By accurately identifying and quantifying both isolated and coincident strain features, PII s assessment process gives operators the early warning needed to mitigate otherwise invisible hazards and avoid pipeline failure.

Solution

Case A: Isolated Strain

A natural gas pipeline, built in the mid 1960s through a mountainous region of Europe, ruptured in March 2014. A comprehensive material analysis found no pre-existing defects, material weakness, wall thickness loss, aging or material damage. Aside from the ruptured pipe body, the steel was in excellent condition and in full compliance with required specifications.

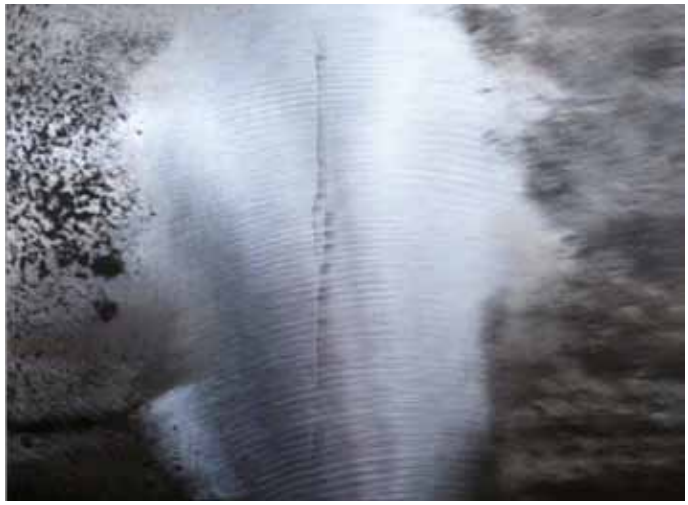
A review of geologic and geodetic data indicated that the slope had shifted over time, with increased movement from 2013. PII examined MFL, caliper and mapping data that was collected six months before the rupture. Although there was no indication of stress raisers at the failure location, it was determined that there had been significant bending strain (>0.5%) present there in 2013. It was therefore concluded that the pipe rupture was caused solely by external loading resulting from continued slope movement.

The pipe steel was in excellent condition; the rupture resulted solely from high shear forces caused by gradual land movement.

Case B: Coincident Features

In 2014, PII inspected a buried pipeline running through an undulating European landscape. The ILI vehicle included MFL, caliper and IMU technologies. In addition to the primary metal-loss inspection, the client commissioned a bending strain assessment as part of the up-front service.

Analysis of IMU data identified an area of significant bending strain (>0.5%), and cross-examination with the MFL data showed that a feature of 39% wall thickness was located in the tensile zone of bending strain. The pipe was excavated and the apparent metal-loss feature was discovered to in fact be a circumferential crack of the reported dimensions. It was repaired, and bending loads were relieved from the line.



What appeared in MFL data to be metal loss, was in fact a circumferential crack coincident with a bending strain peak.

Benefits

Landslides and other geological events may appear to happen suddenly, but they are almost always preceded by longer intervals of incremental ground movement. While dangerous strain can occur in a wide range of environments, of key concern are areas prone to seismic activity, frost heave, river washouts or flooding, or subsidence related to mining.

Even low magnitudes of ground movement can cause hazardous pipe strain, which can be measured through advanced IMU data analysis. Additionally, since strain can often go undetected, a strain assessment can provide operators the early warning needed to mitigate threats, identify coincident features, and avoid pipeline failures.

Moreover, IMU modules can be included in many PII in-line inspections for a fractional cost. If a strain analysis isn't part of the original project mandate, the data is always saved and therefore available for future integrity needs.

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