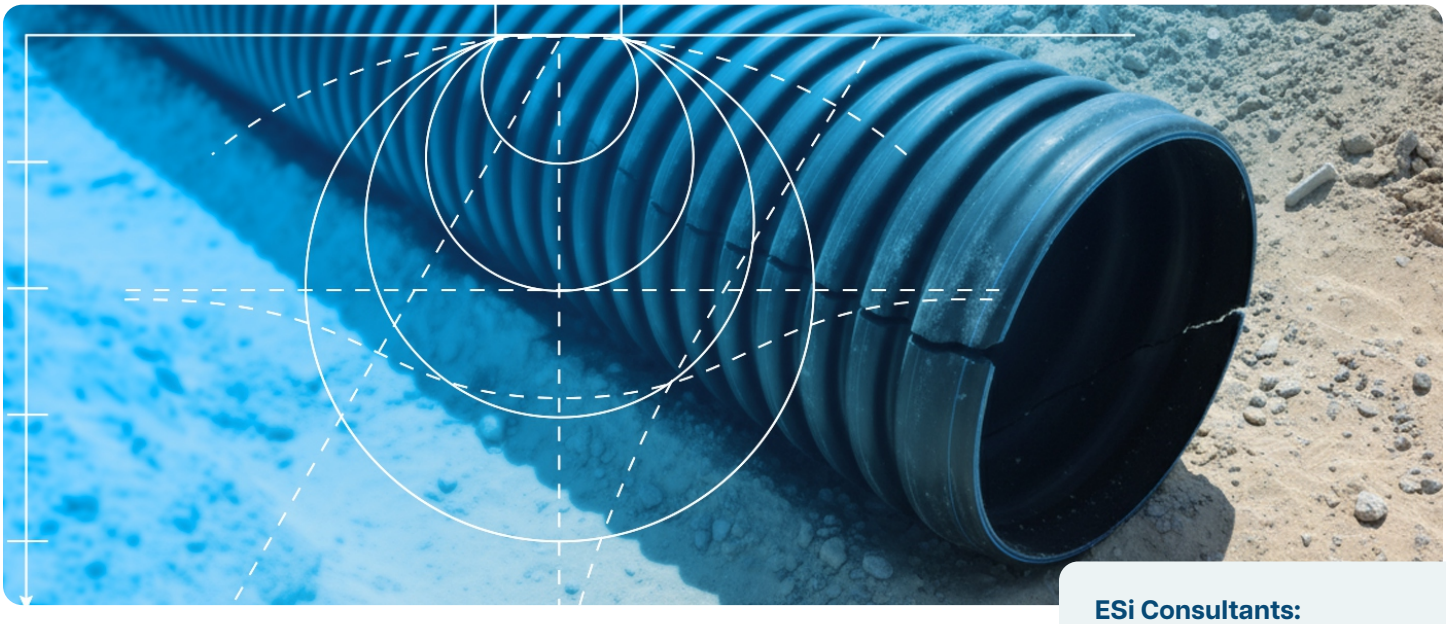

# Large Diameter (5-feet) Corrugated HDPE Pipe Failure Analysis

**ESi performed a failure analysis of a large diameter (5-feet) corrugated HDPE pipe used in storm water management. Fractographic examination and material testing revealed the root-cause of failure was not related to extreme service conditions in Bahrain (Persian Gulf region) but caused by surface loading due to heavy machinery.**

## The Situation

A petroleum company working at an oil refinery facility in Bahrain contacted ESi to conduct a failure analysis of a large diameter (60-inch) high density polyethylene (HDPE) corrugated pipe used in a buried stormwater management pipeline. The double-wall large diameter HDPE pipe featured external corrugations connected to an internal pipe liner. Pipe failure caused storm water to escape causing land erosion and road collapses. The HDPE pipe failure created safety concerns at the refinery facility and led to delays in the construction schedule. ESi was retained to perform a root-cause failure analysis so that proper actions could be taken to prevent additional failures during the ongoing construction of the oil refinery facility.

## Our Approach

ESi conducted a comprehensive failure analysis investigation combining laboratory analysis and engineering evaluation. We coordinated with the client to review background information, preliminary site assessment data,

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Gaurav Nagalia
Senior Staff Consultant

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Principal and Director

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Senior Managing Consultant

**Services Utilized:**

- Failure Analysis
- Materials Testing
- Lab & Inspection Services

## Our Approach *cont*

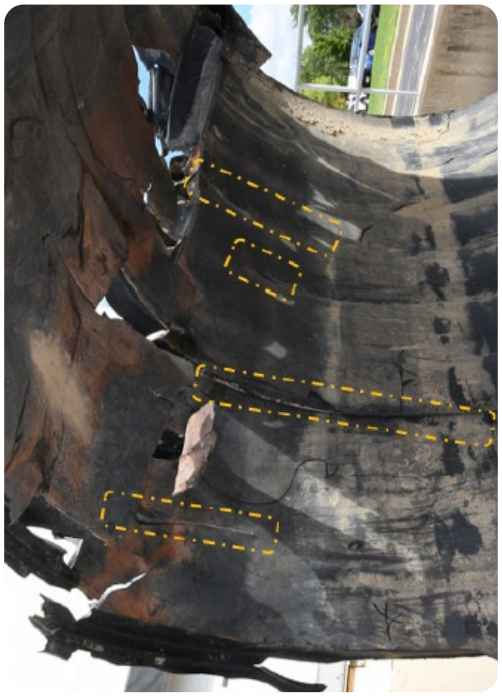
and relevant technical literature including product data sheets and applicable test standards. Laboratory analysis consisted of visual examination, dimensional measurements, and material testing per AASHTO M-294 and ASTM D3350 standards. To determine if oxidative degradation had occurred, HDPE material was evaluated using Fourier Transform Infrared (FTIR), AND oxidative induction time studies were performed using Differential Scanning Calorimeter (DSC) to evaluate the presence of antioxidant additives in the HDPE material formulation.

Fractographic analysis conducted using optical microscopes identified crack initiation points and crack propagation markings in both external corrugations and internal liner, allowing ESi to identify the fracture sequence through systematic analysis of the crack orientation and appearance. The analysis revealed the HDPE pipe had experienced buckling from compressive loading and failed due to circumferential cracks developing in the corrugations. Our review of the installation documentation, quality control records, and design specifications with the client's project team revealed that construction activities caused heavy machinery to be parked over the pipeline location.

## The Outcome

Material analysis confirmed that HDPE material degradation had not occurred in service, rather long-term mechanical loading induced circumferential cracking along the external corrugations. This shifted the structural loads to the thin-walled inner liner which in turn caused liner buckling and failure via slow crack growth mechanism with longitudinal cracking resulted from fast fracture.

Our analysis enabled immediate remediation of road collapses and informed enhanced design considerations for future pipeline installations. The findings provided critical insights for double-wall corrugated pipe performance under construction loading, preventing similar failures throughout the facility and contributing valuable knowledge for petroleum industry infrastructure projects.



*Overview of circumferential through wall cracking in the corrugations and longitudinal through wall cracking in the inner liner component of the subject 60-inch HDPE stormwater pipe segments provided.*

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