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Studies on the Effects of Crack Orientation and Rate of Loading in Thin Walled Seam Welded and Seamless Tubes Made up Ti-Alloy

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ABSTRACT

The crisis of tube fracture due to internal pressure loading (static or dynamic) has importunate to draw awareness because of its engineering significance and the industrial application it offers. This is a strongly coupled fluid-structure-fracture problem. The internal pressure induces the structural deformation, which provides the driving force for crack extension. The opening crack(s) and large structural deformation in turn govern the gas dynamics. The problem has wide civilian and military applications such as oil, gas, and water transmission and distribution pipeline systems, pressurized aircraft fuselages, rocket casings, space station modules, and gun tubes.

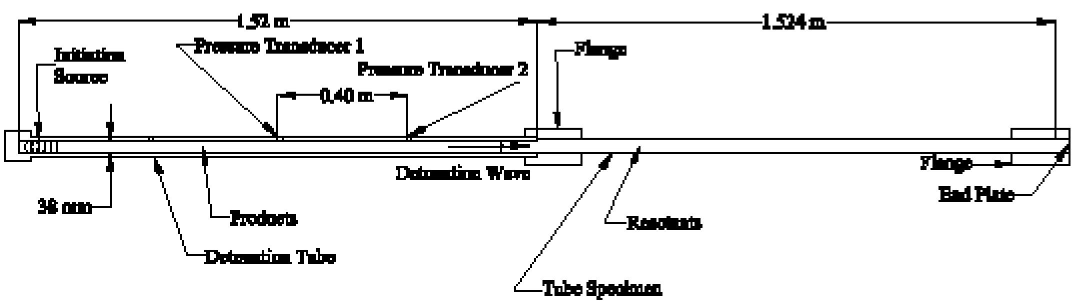

Figure 1: Tube assembly schematic for detonation experiment.

This research work is aimed at gaseous detonation-driven fracture of tubes. The specific problem studied here, differing from traditional detonation-driven tube fragmentation, involves a tube that has been deliberately preflawed axially on the surface. The preflaw is made to control the crack initiation site. If there was no preflaw, cracks could start anywhere on the tube and the resultant stochastic rupture would be intractable to deterministic fracture mechanics analysis. A gaseous detonation wave is sent through this preflawed tube, and the crack is initiated due to the oscillating hoop stress set up by the traveling detonation wave. The crack grows into the inner wall, creating a through-wall crack. The breach allows gaseous reactants to escape, sending a shock wave into the ambient air and expansion waves into the tube which relieves the dynamic stresses. Two crack fronts run upstream and downstream in straight paths for some distance. Depending on the crack driving force, these cracks may or may not branch. The cracks then turn along helical paths and are arrested.

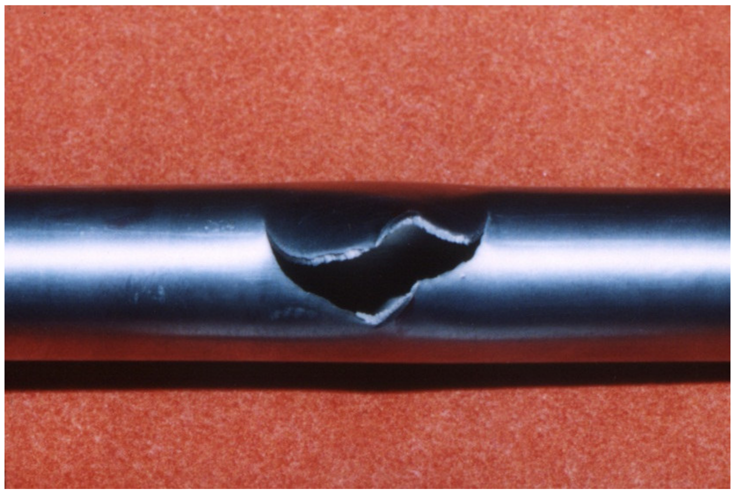

Figure 2: Piper after burst.

There has been no existing study in the literature on such a problem. Substantial efforts have been made on studying initially quasi-statically pressurized tube fracture with preflaws or fragmentation of tubes due to explosions or detonations without preflaws. Combining preflaws and traveling loads to make the detonation-driven tube fracture problem tractable to fracture mechanics analysis is an innovation in this study.

References:

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