# THE ANALYSIS OF GRIND REPAIRS IN PRESSURE VESSELS

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Periodic inspections of pressure vessels can reveal defects which require assessment and possibly repair before the vessels can be returned to service. One of the commonest defects in pressure vessels is the surface breaking defect at a fillet weld toe. Such defects are normally ground out, not only to remove the (sharp) defect but also to size it in the through-thickness dimension. However, the grind repair is itself a defect, whose fitness-for-purpose must be assessed. This paper compares fitness-for-purpose methods and recommends one particular approach.

## INTRODUCTION

Pressure vessels are periodically inspected in-service to ensure optimum and safe performance. Defects are sometimes detected which are outside the acceptance levels of the original fabrication standard. Surface-breaking defects at fillet weld toes are among the commonest defects found, and normal practice is to grind repair such defects. However, this grind repair must itself be assessed to ensure its fitness-for-purpose, as recognised by Hopkins (1).

The fatigue properties of grind repairs have been studied as part of a study on pressure vessel weld defects (1). This paper compares the results of an experimental programme with theoretical predictions.

## EXPERIMENTAL PROGRAMME

The experimental programme was conducted on grind

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repairs in small scale test plates with fillet welded attachments. The 25 mm thick plates contained 6 mm deep grind repairs at the weld toes. They were fatigue cycled in either tension or four-point bending over a nominal stress range of 233 MPa, Figure 1.

## FITNESS-FOR-PURPOSE ASSESSMENTS

The experimental results were analysed in terms of fatigue crack initiation and propagation.

### Fatigue Crack Initiation

Two methods for predicting fatigue crack initiation were investigated. First, the criterion of Rolfe and Barsom (2) was found to be, in most cases, unconservative ie grinds predicted to be stable, in fact, initiated.

Second, the British Gas test results were combined with the fatigue crack initiation data of Wylde and Haswell (3), and Gibstein et al (4), but the resulting lower bound experimental line gave unconservative predictions at high stress levels, Figure 2.

### Fatigue Crack Propagation

Two methods for predicting fatigue crack propagation were investigated. First, the cracks were assumed to be sharp cracks and assessed using fatigue fracture mechanics, ie the Paris-Erdogan Law (5). Second, the Welding Institute Fatigue Design Line (6) was compared with the data, Figure 2. The comparison was based on peak stress ie nominal stress x stress concentration factor for the grind.

Both these methods gave conservative predictions of the test data, but the fatigue fracture mechanics method is easier, as it does not require knowledge of the stress concentration factor.

It is therefore recommended that a grind repair in a pressure vessel weld be assessed using fatigue fracture mechanics, assuming the grind repair is a sharp crack of dimensions (length and through-thickness depth) equal to the repair.

## REFERENCES

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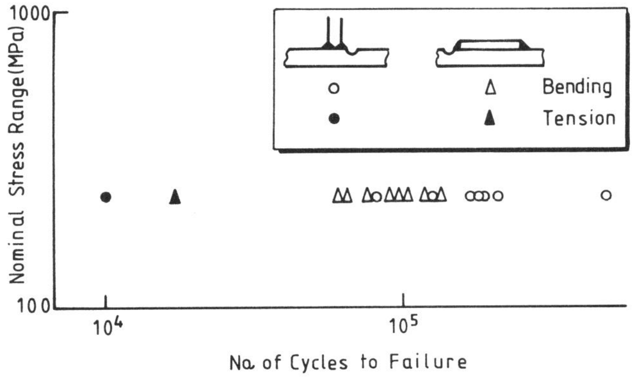


Figure 1 British Gas Fatigue Test Results

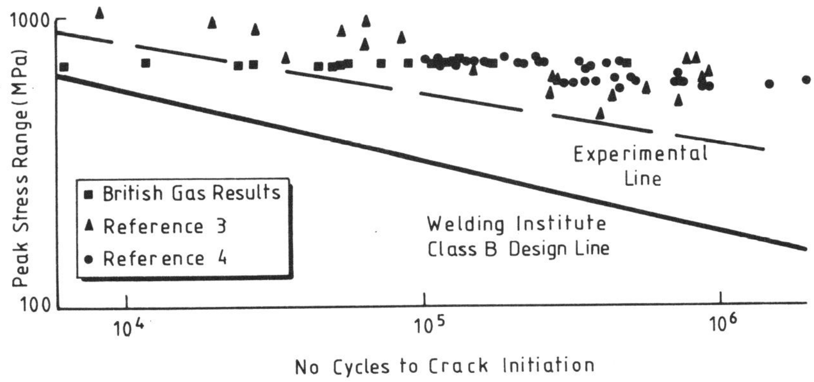


Figure 2 Fatigue Test Results from Small Scale Tests