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# Industrial Member Report Summary – Key Findings for Industry

## A Simplified Geometry for FEA Investigation of the Characteristics of Secondary Stresses

TWI Core Research Programme

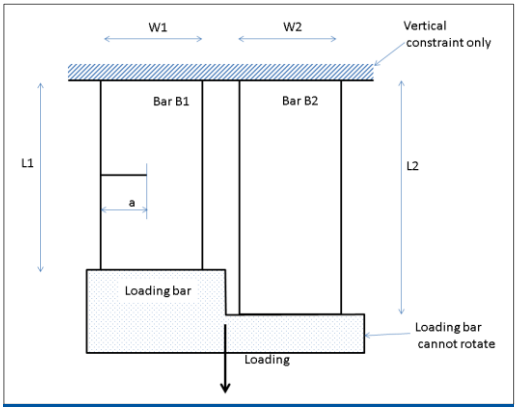
Authors: Simon Smith and Emily Hutchison

## Introduction

Secondary stresses, such as welding residual stresses, must be considered in all engineering critical assessments. The interaction between primary and secondary stresses is complex and not fully characterised in current assessment procedures such as BS 7910 and R6.

## Industrial Challenge

Welds can contain defects that are either original features from fabrication or features that initiate and grow under the in-service conditions of load and environment. It is important to understand the critical size of these features for the extremes of loading experienced. Fitness-For-Service (FFS) assessment codes like API 579-1/ASME FFS-1 2007, DNV-RP-F108, R6 and BS 7910 provide guidance for the assessment of the potential stable and unstable growth of weld defects. The codes estimate crack tip loading based on a division of the loading into primary and secondary components. Both types of load produce crack loading, but only primary stresses are assumed to cause plastic collapse.




Cracked Two Bar Structure (CTBS)

Ainsworth developed a method to encompass the interaction of primary and secondary stresses in 1986. The 1986 paper introduced the "rho factor" (ρ) that enabled the difference between elastic superposition and the actual behaviour under elastic-plastic fracture mechanics to be assessed. To-date, there has generally been considerable misunderstanding about the use of ρ amongst the engineers who perform FFS studies.

The range over which a secondary stress acts can determine how it interacts with primary stresses. A short range secondary stress acts purely as a secondary stress, whereas a long range secondary stress can behave like a primary stress. The transition between these two states can be defined using an elastic follow up parameter. This is not well understood or characterised in the FFS codes.

## Key Findings

- A simple test geometry, a cracked two bar structure (CTBS), has been developed to assess the interaction between primary and secondary stresses.
- The long range characteristic of secondary stress applied to the model can be adjusted easily using the length of one bar. Hence, the CTBS can be used to investigate the effect of elastic follow up.
- A simple equation for the true crack tip loading under a combination of secondary and primary loads has been proposed, assuming that secondary stresses are primary at low load and completely lost at a critical applied strain.

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