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Industrial Member Report Summary – Key Findings for Industry

Developing M_k Solution for Fatigue Crack Growth Assessment of Flaws at Weld Root Toes in Girth Welds

TWI Core Research Programme

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Industrial need

Engineering critical assessment is widely used in the offshore industry to determine the maximum tolerable initial flaw size in girth welds for pipelines and risers. To account for the effect of the stress concentration factor at the weld toe on the stress intensity factor range, ΔK, a magnification factor, M_k, is used. For single-sided girth welds, fatigue cracking often initiates from weld toes on the root side, rather than on the weld cap side. Existing M_k solutions given in BS 7910 were developed for fatigue assessment of flaws at the toes of fillet and butt welds and may not be suitable for assessing flaws at girth weld root toes, where the weld width is relatively small.

Key Findings

M_k solutions and parametric equations for three different defect models were developed and established. It was found that:

- The weld toe angle at the weld root has a negligible effect on the M_k.
- For Type I defects (weld root hi-lo=0), the BS 7910 2D solution provides an upper bound for M_k.
- For Type II (weld root bead height = hi-lo) and Type III (weld root bead height≠hi-lo) defects, M_k values are significantly greater than for Type I defects, and increase sharply with increasing hi-lo.
- The accuracy of the M_k solution developed was confirmed by experimental data in terms of both fatigue crack growth and S-N curve approaches.
- For girth weld roots with hi-lo>0.25mm, the guidance given in DNV-OS-F101:2013 is non-conservative.

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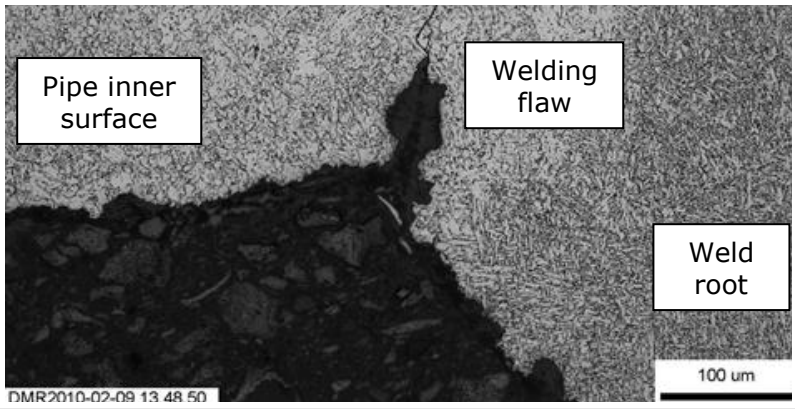
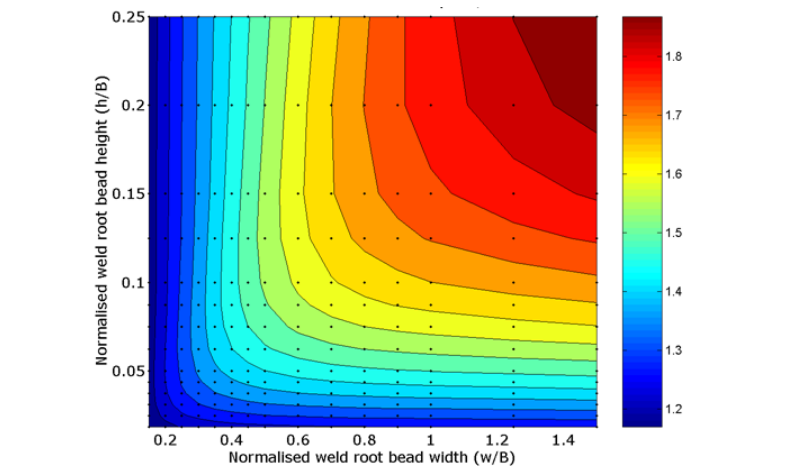


Cross-section of a typical flaw at a girth weld root bead toe.



M_k as a function of normalised weld root bead width (x-axis) and normalised weld root bead height (y-axis) (crack size/thickness=0.011)