E. Quantitative Analysis Techiques for Assessing Engineering Sigficance of Weld Imperfections

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Various imperfections invariably exist in welded joints. These include porosities, planar indications of various sizes or shapes, residual stresses, etc. Engineers frequently confront themselves with questions like what constitutes a good weld for intended applications and how to quantitatively demonstrate that a weld, although containing a certain level of imperfections, is fit for intended design performance in a product.

In this presentation, recent developments in quantitative analysis techniques for evaluating various weld imperfections are summarized. These include:

- Weld pool dynamics simulation techiques
- Hybrid polygonal element techniques for assessing randomly distributed micro cracks and porosity
- Mesh-insensitive structural stress method for characterizing stress concentration at both global level (e.g., joint types) and local notch stresses
- Residual stress decomposition and fracture mechanics treatment techniques for fitness for purpose based assessment

In discussing the above techniques, the engineering implications of various types of weld imperfections on structural performance will be demonstrated by considering a series of real world examples, including:

- Resistance spot welds and laser welds in aluminum alloys and high strength steels: effects of porosity and micro crack on strength and fatigue performance
- Imperfection length scale and space distribution characteristics in weld quality definitions in the context of MIL-STD-2219
- Repair welds in super lightweight shuttle tank: residual stresses and mitigation techniques
- Residual stress characteristics in temper bead nuclear vessel repair welds and effects on defect assessment