Finite Element Model study of the Effect of Corner Rounding on Detectability of Corner Cracks using Bolt-Hole Eddy Current

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Recent work has shown that the detectability of corner cracks in bolt-holes is compromised when rounding of corners arises, as might occur during bolt-hole removal. Probability of Detection (POD) studies normally require a large number of samples of both fatigue cracks and electric discharge machined notches. In the particular instance of rounding of bolt-hole corners, the generation of such a large set of samples representing the full spectrum of potential rounding would be prohibitive. In this paper, the application of Finite Element Method (FEM) modeling is used to supplement the study of detection of cracks forming at the rounded corners of bolt-holes. FEM models show that rounding of the corner of the bolt-hole reduces the size of the response to a corner crack to a greater extent than can be accounted for by loss of crack area. This reduced sensitivity can be ascribed to a lower concentration of eddy currents at the rounded corner surface and greater lift-off of pick-up coils relative to that of a straight-edge corner. A rounding with a radius of 0.4 mm (.016 inch) showed a 20% reduction in the strength of the crack signal. Assuming linearity of the crack signal with crack size, this would suggest an increase in the minimum detectable size by 25%. Modeling results are consistent with measurements performed on cracks grown on bolt-hole samples extracted from service.