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Theoretical investigations into the use of linear and nonlinear inhomogeneous waves for non-destructive testing

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Following the shift to incorporate more materials by design into modern engineering is the theoretical need to model an increasingly more complicated material structure and predict a design life for complex engineered materials. The presence of defects, interface cracks and delaminations adds to the inherent nonlinearity of a structure by degrading material stiffness and other physical properties contributing to fracture. The presence of local defects either at interfaces between two different materials or grain boundaries within the bulk material provide a natural location for the formation and subsequent propagation of cracks. This work provides initial theoretical investigations into the use of ultrasonic inhomogeneous waves to nondestructively probe such interface defects. Characterized theoretically by a complex valued wave number, the inhomogeneous wave is the more general plane wave solution of the wave equation. The complex valued wave number allows for the material effects of damping along the propagation direction and wave inhomogeneity or amplitude decay along the wavefront. To study the interaction with cracks, a singular integral equation formulation like that of Krenk and Schmidt is extended to farfield simulations with ultrasonic inhomogeneous waves.