Journal of Nondestructive Evaluation, Diagnostics and Prognostics of Engineering Systems

Numerical analysis of guided wave transmission through a long defect in a rail rack

Loveday, PW; Long, Craig S

Abstract:
Guided wave ultrasound has been used to continuously monitor welded rail track by transmitting guided wave ultrasound between alternate transmit and receive stations along the rail. A section of rail was encountered where transmission was not reliably achieved. It was found that there was considerable flank wear on the head of the rail, which varied in a sinusoidal pattern over approximately 10 m. The scattering due to the wear is investigated in this paper using numerical modeling. A 3D finite element (FE) model of the section of rail containing the wear defect was coupled to two semi-analytical finite element models of the incoming and outgoing waveguides. In the case of a 10 m long defect, which is over 100 wavelengths long, the 3D FE matrices were excessively large, and the global matrices could not be assembled nor solved. An approach of successively assembling layers of the mesh and reducing out internal degrees-of-freedom in the dynamic stiffness matrix was successfully adopted. The influence of the length of wear on the transmission loss was computed. It was found that short wear lengths generally cause more transmission loss although the relationship is not monotonic. It was found that the long-wear seen in the field does not cause transmission loss. In this case, where the change in cross section is gradual the incoming mode converted to a single mode in the smallest cross section and this mode converted back to the incoming mode in the second half of the wear section.