Public Abstract
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Title:Ultrasonic Biaxial Stress Measurement for Evaluating the Adequacy of Gusset Plates

The collapse of the I-35W bridge in Minneapolis, Minnesota, on August 1, 2007, resulted in the deaths of 13 people. In an investigation conducted by the National Transportation Safety Board, the cause of the collapse was determined to be the failure of an overstressed steel gusset plate which connected key members of the structure. Following the collapse, State Departments of Transportation sought to confirm the adequacy of gusset plates in other bridges to ensure overstressed gusset plates were not present. Total stresses in a gusset plate cannot be effectively determined using conventional tools such as strain gages. The goal of this research was to improve the safety of steel truss highway bridges by developing an ultrasonic stress measurement methodology for determining total stress in steel gusset plates. A methodology was developed and assessed based on the results of laboratory testing in which the accuracy and precision of ultrasonic stress measurements for a biaxial stress condition were evaluated. This research utilized the acoustoelastic effect to evaluate total stress levels by assessing the acoustic birefringence in steel. The birefringence measurement evaluates normalized variations of polarized shear waves propagating through the plate thickness; these shear waves vary proportionally as a function of stress. A sine regression technique was applied to measure the desired birefringence parameters. Testing results indicated stress measurement uncertainties of 2,600 psi (12.5% of the shear yield strength) or less. This study demonstrated the potential of the sine regression technique to accurately and repeatedly assess total stress levels in steel gusset plates.