# THE UNIVERSITY OF CONNECTICUT
## CIVIL & ENVIRONMENTAL ENGINEERING



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**DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING**
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**CAST 306**

***Advisory Committee:***
Dr. Shinae Jang (Major Advisor)
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## STRUCTURAL HEALTH MONITORING OF CRITICAL LOAD-CARRYING MEMBERS

ABSTRACT


The structural integrity of transportation infrastructure relies greatly on the condition of critical load-carrying members. Many in-service highway bridges use primary beams with welded cover plates that provide greater flexural capacity in regions of high-applied moment. The cyclic loading pattern of a bridge induces fatigue damage starting from the toe of the welds due to high stress concentrations. The crack propagates well into the beam's web, reducing flexural capacity. This behavior is present in other typical connection details where stress concentrates greatly, such as floor-beams to main truss connections, diaphragms and cross-bracing connections, copied and cut-short beam ends, and stringer-to-floor beam connections. Main tension elements in cable-supported bridges also suffer fatigue and corrosion damage, which can be greatly challenging to detect with conventional visual inspection methods. This damage can reduce tension capacity sufficiently to require early replacement of stay cables. Structural health monitoring (SHM) methods provide an objective and quantitative option for structural assessment. Cracks in steel members can be monitored at a low cost with commercial radio frequency identification (RFID) tags. An RFID-based crack sensor has been developed and experimentally assessed. This crack sensor uses wireless technology and a simple damage extraction feature to characterize crack width and identify initial crack formation. A guideline for sensor deployment has been established considering its damage sensitivity on metallic surfaces. For tension monitoring in cable structures, a new smart wireless system capable of using ambient vibration measurements for cable tension estimation has been developed. The same vibration measurements collected for cable tension estimation can be used to identify damage using a flexibility-based damage identification method. This damage identification algorithm has been modified to automate calculation and improve accuracy in damage quantification and location. These developments present a relevant advancement in simple, low-cost, and reliable SHM that provides practical information to bridge owners for intelligent decision-making.