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Mohamed, D.[a] , Hrairi, M.[b]

Real-Time Structural Damage Detection Using EMI under Varying Load a and Temperature Conditions
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[a] National Higher School of Technology and Engineering, 2000 pedagogical places Sidi, AmarAnnaba, Algeria
[b] International Islamic University Malaysia, P.O. Box 10, Kuala Lumpur, 50728, Malaysia

Abstract
Structural Health Monitoring (SHM) is a critical aspect of maintaining the safety and integrity of infrastructure. In recent years, there has been a significant shift towards adopting innovative techniques, and one of the most promising methods is Electromechanical Impedance (EMI). EMI involves the utilization of piezoelectric transducers to assess the health of structures in real-time by examining changes in their electrical characteristics. The presence of load causes a change in structural stiffness, which alters the resonant characteristics of the structure. Understanding how external factors like load and temperature influence the electrical impedance of these sensors is essential for its reliable application in damage detection. This article presents an experimental and numerical study to investigate the effects of load and temperature on the electrical impedance of a piezoelectric sensor used in the electromechanical impedance (EMI) technique. The experimental setup uses an impedance analyzer (Agilent 4294A model) to measure the in-situ EMI of piezoelectric wafer active sensors (PWAS) attached to the monitored structure. The numerical model uses ANSYS software to simulate an aluminum beam at varying temperatures. The results show that the load and temperature have a significant effect on the impedance of the transducer. However, it is shown that it is still possible to detect damage using EMI even under varying load and temperature conditions. The results also show that the accuracy of EMI-based damage detection can be improved by using temperature and load compensation techniques. © 2023 Published by ISRES Publishing: www.isres.org.

Author Keywords
Electromechanical impedance; Load detection; Piezoelectric sensor; Structural health monitoring; Temperature compensation

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Correspondence Address
Mohamed D.; National Higher School of Technology and Engineering, 2000 pedagogical places Sidi, Algeria; email: m.djemana@ensti-annaba.dz

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