Scopus

Documents

Aabid, A.[a] , Hrairi, M.[b] , Mohamed Ali, J.S.[b]

Optimization of damage repair with piezoelectric actuators using the Taguchi method
(2024) *Frattura ed Integrita Strutturale*, 18 (67), pp. 137-152.

DOI: 10.3221/IGF-ESIS.67.10

[a] Department of Engineering Management, College of Engineering, Prince Sultan University, PO BOX 66833, Riyadh, 11586, Saudi Arabia
[b] Department of Mechanical and Aerospace Engineering, Faculty of Engineering, International Islamic University Malaysia, P.O. Box 10, Kuala Lumpur, 50725, Malaysia

Abstract
Over the last two decades, piezoelectric actuators have emerged as a promising solution for structural repair. In this work, initially the stress intensity factor (SIF) estimation using the finite element (FE) approach at crack tips in aluminium 2024-T3 plates. Based on Taguchi's L9 orthogonal array the FE simulation has been conducted. Later, this study uses the optimization method via the design of experiments to systematically evaluate the effect of various dimensions and material qualities, especially under the conditions of Mode-I crack propagation. It also investigated the complex interaction of factors impacting adhesive bonds, piezoelectric actuators, and aluminium plates, The study not only analyses the parameter relationships but also examines their controls, identifying those best aligned with primary objectives. This sensitivity enhances the piezoelectric actuator's efficacy and quality. The research determines an optimal parameter combination, developing active repair performance and establishing an essential SIF benchmark. This research explores the complex world of piezoelectric actuator-assisted repairs, providing a road map for better structural rehabilitation.

Author Keywords
Active control; Cracks; Finite element method; Optimization; PZT material; Structures

Index Keywords
Adhesives, Aluminum, Benchmarking, Crack tips, Design of experiments, Piezoelectric actuators, Plates (structural components), Repair, Structural optimization, Taguchi methods; Active control, Aluminum 2024-T3, Damage repair, Finite-element approach, L9 orthogonal arrays, Optimisations, PZT materials, Stress-intensity factors, Structural repairs, Taguchi's methods; Finite element method

References

- De Maio, U., Gaetano, D., Greco, F., Lonetti, P., Pranno, A.
  The damage effect on the dynamic characteristics of FRP-strengthened reinforced concrete structures
  (2023) *Compos. Struct*, 309 (January), p. 116731.
- Cha, Y.J., Buyukozturk, O.
  Structural damage detection using modal strain energy and hybrid multiobjective optimization
  (2015) *Comput. Civ. Infrastruct. Eng*, 30 (5), pp. 347-358.
- Wang, Q., Quek, S.T., Liew, K.M.
  On the repair of a cracked beam with a piezoelectric patch
  (2002) *Smart Mater. Struct*, 11 (3), pp. 404-410.
- Wang, Q., Quek, S.T.
  Repair of cracked column under axially compressive load via piezoelectric patch
  (2005) *Comput. Struct*, 83 (15–16), pp. 1355-1363.
- Rogers, C.A.
  Intelligent Material Systems — The Dawn of a New Materials Age
  (1993) *J. Intell. Mater. Syst. Struct*, 4 (1), pp. 4-12.

- Wang, Q., Duan, W.H., Quek, S.T.
Repair of notched beam under dynamic load using piezoelectric patch
(2004) *Int. J. Mech. Sci*, 46 (10), pp. 1517-1533.

- Shah, D.K., Joshi, S.P., Chan, W.S.
Stress concentration reduction in a plate with a hole using piezoceramic layers
(1994) *Smart Mater. Struct*, 3 (3), pp. 302-308.

- Alaimo, A., Milazzo, A., Orlando, C.
On the dynamic behavior of piezoelectric active repair by the boundary element method
(2011) *J. Intell. Mater. Syst. Struct*, 22 (18), pp. 2137-2146.

- Alaimo, A., Milazzo, A., Orlando, C.
Boundary elements analysis of adhesively bonded piezoelectric active repair
(2009) *Eng. Fract. Mech*, 76 (4), pp. 500-511.

- Platz, R., Stapp, C., Hanselka, H.
Statistical approach to evaluating reduction of active crack propagation in aluminum panels with piezoelectric actuator patches
(2011) *Smart Mater. Struct*, 20 (8), p. 085009.

- Abuzaid, A., Hrairi, M., Dawood, M.S.I.
Survey of Active Structural Control and Repair Using Piezoelectric Patches
(2015) *Actuators*, 4 (2), pp. 77-98.

- Abuzaid, A., Hrairi, M., Dawood, M.S.
Modeling approach to evaluating reduction in stress intensity factor in center-cracked plate with piezoelectric actuator patches
(2017) *J. Intell. Mater. Syst. Struct*, 28 (10), pp. 1334-1345.

- Abuzaid, A., Hrairi, M., Dawood, M.S.
Experimental and numerical analysis of piezoelectric active repair of edge-cracked plate
(2018) *J. Intell. Mater. Syst. Struct*, 29 (18), pp. 3656-3566.

- Abuzaid, A., Dawood, M.S., Hrairi, M.
Effects of Adhesive Bond on Active Repair of Aluminium Plate Using Piezoelectric Patch
(2015) *Appl. Mech. Mater., 799–800*, pp. 788-793.

- Abuzaid, A., Shaik Dawood, M.S.I., Hrairi, M.
The effect of piezoelectric actuation on stress distribution in aluminum plate with circular hole
(2015) *ARPN J. Eng. Appl. Sci*, 10 (21), pp. 9723-9729.

- Aabid, A., Hrairi, M., Dawood, M.S.I.S.
Modeling Different Repair Configurations of an Aluminum Plate with a Hole
(2019) *Int. J. Recent Technol. Eng*, 7 (6S), pp. 235-240.

- Anjum, A., Aabid, A., Hrairi, M.
Analysis of damage control of thin plate with piezoelectric actuators using finite element and machine learning approach
(2023) *Frat. Ed Integrita Strutt*, 66, pp. 112-126.

- Aabid, A., Hrairi, M., Mohamed Ali, S.J., Ibrahim, Y.E.
Review of Piezoelectric Actuator Applications in Damaged Structures: Challenges and Opportunities
(2023) *ACS Omega*, 8, pp. 2844-2860.

- Aabid, A., Parveez, B., Raheman, M.A., Ibrahim, Y.E., Anjum, A., Hrairi, M., Parveen, N., Zayan, J.M.
  A review of piezoelectric materials based structural control and health monitoring techniques for engineering structures: challenges and opportunities
  (2021) *Actuators*, 10 (5), p. 101.

- Aabid, A., Raheman, A., Ibrahim, Y.E., Anjum, A., Hrairi, M., Parveez, B., Parveen, N., Zayan, J.M.
  A Systematic Review of Piezoelectric Materials and Energy Harvesters for Industrial Applications
  (2021) *Sensors*, 21, pp. 1-28.

- Crew, F. A. E., Edinburgh, D., Ward Cutler, R.
  (1934) *Statistical Methods for Research Workers*,
  London

- Montgomery, D.C.
  (2013) *Design and Analysis of Experiments*,
  John Wiley & Sons, Inc

- Aabid, A., Hrairi, M., Ali, J.S.M.
  Optimization of composite patch repair for center-cracked rectangular plate using design of experiments method
  (2020) *Mater. Today Proc*, 27, pp. 1713-1719.
  (Part 2)

- Aabid, A.
  Optimization of Reinforcing Patch Effects on Cracked Plates Using Analytical Modeling and Taguchi Design
  (2023) *Materials (Basel)*, 16 (12), p. 4348.

- Aabid, A., Ibrahim, Y.E., Hrairi, M.
  Optimization of Structural Damage Repair with Single and Double-Sided Composite Patches through the Finite Element Analysis and Taguchi Method
  (2023) *Materials (Basel)*, 16 (4), p. 1581.

- Aabid, A., Hrairi, M., Ali, J.S.M., Sebaey, T.A.
  A Review on Reductions in the Stress-Intensity Factor of Cracked Plates Using Bonded Composite Patches
  (2022) *Materials (Basel)*, 15 (3086), p. 20.

- Aabid, A., Baig, M., Hrairi, M.
  Advanced Composite Materials for Structural Maintenance, Repair, and Control
  (2023) *Materials (Basel)*, 16 (2), pp. 1-3.

- Aabid, A., Hrairi, M., Abuzaid, A., Mohamed Ali, J.S.
  Estimation of stress intensity factor reduction for a center-cracked plate integrated with piezoelectric actuator and composite patch
  (2021) *Thin-Walled Struct*, 158.

- Aabid, A.
  (2020) *Hybrid repair of cracked plates strengthened with composite patches and piezoelectric actuators*,
  International Islamic University Malaysia

- (2017) *ANSYS FLUENT 18.0: Theory Guidance*,
  Canonsburg PA

- Samaei, M., Zehsaz, M., Chakherlou, T.N.
  Experimental and numerical study of fatigue crack growth of Aluminum alloy 2024-

T3 single lap simple bolted and hybrid (adhesive / bolted) joints
(2015) *Eng. Fail. Anal. J*,

- Sun, G., Liu, X., Zheng, G., Gong, Z., Li, Q.
On fracture characteristics of adhesive joints with dissimilar materials-An experimental study using digital image correlation (DIC) technique
(2018) *Compos. Struct*,

- Tada, H., Paris, P.C., Irwin, G.R.
(2000) *The Stress Analysis of Cracks Handbook*,
Third Edition

- Yala, A.A., Megueni, A.
Optimisation of composite patches repairs with the design of experiments method
(2009) *Mater. Des*, 30, pp. 200-205.

- Yala, A.A., Demouche, N., Beddek, S., Hamid, K.
Full Analysis of All Composite Patch Repairing Design Parameters, Iran
(2018) *J. Mater. Sci. Eng*, 15 (4), pp. 70-77.

- Fekih, S.M., Albedah, A., Benyahia, F., Belhouari, M., Bouiadjra, B.B., Miloudi, A.
Optimisation of the sizes of bonded composite repair in aircraft structures
(2012) *Mater. Des*, 41, pp. 171-176.

- Richard, N.M.
(2014) *How To Use MINITAB: Design Of Experiment*,

- Clements, R.B.
(1991) *Handbook of Statistical Methods in Manufacturing*,
Prentice Hall Direct

Correspondence Address
Hrairi M.; Department of Mechanical and Aerospace Engineering, P.O. Box 10, Malaysia; email: meftah@iium.edu.my

Publisher: Gruppo Italiano Frattura

ISSN: 19718993
Language of Original Document: English
Abbreviated Source Title: Frat. Integrita Strutr.
2-s2.0-85179884654
Document Type: Article
Publication Stage: Final
Source: Scopus