

Structures

Papers Presented at the AIAA SciTech Forum and Exposition
2025

Orlando, Florida, USA
6 - 10 January 2025

Volume 1 of 2

ISBN: 979-8-3313-1815-4

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

The contents of this work are copyrighted and additional reproduction in whole or in part are expressly prohibited without the prior written permission of the Publisher or copyright holder. The resale of the entire proceeding as received from CURRAN is permitted.

For reprint permission, please contact AIAA's Business Manager, Technical Papers. Contact by phone at 703-264-7500; fax at 703-264-7551 or by mail at 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191, USA.

TABLE OF CONTENTS

VOLUME 1

ADDITIVE STRUCTURES

Digital Twins of Additive Manufacturing Parts for Fatigue Life Prediction	1
<i>Xueyong Qu, Leland Shimizu, Jacob Rome, Vinay K. Goyal</i>	
Development of a 3D Printed Optimization-Driven Aeroelastically Scaled Wind Tunnel Model for High Aspect Ratio Flying Wings	13
<i>Mikaela Leevy, Suraj Gattu, Robert M. Taylor, Kevin McHugh, Nicholas Jones</i>	
Comparison of Collapse Behavior of Ant Nest Derived Porous Geometries in Geological and Engineered Materials	30
<i>Tyler Felgenhauer, Satchi Venkataraman, Carter Johnson</i>	
Lattice Cell Assisted Topology Optimization of an Extendable Wing for Munition	45
<i>Bugra Aksoy, Altan Kayran</i>	
Mechanical Response of Cylindrically Mapped Triply Periodic Minimal Surface Structures Under Combined Loading	60
<i>Jay B. Patel, John S. Brewer, Ryan A. Kemnitz, Elizabeth Bartlett</i>	

FATIGUE, FRACTURE, AND IMPACT DAMAGE OF STRUCTURES I

Progressive Failure Analysis and Open-Hole Compressive (OHC) Strength Prediction of Laminates	76
<i>Vignesh Shankar Iyer, Minh Hoang Nguyen, Royan J. D'mello, Anthony M. Waas</i>	
Strain Energy Based Fatigue Life Prediction of Metallic Materials	87
<i>Agam Sharan, Ashish Srivastava, Mira Mitra</i>	
Reusable Launch Vehicles: Designing Legs for Propulsive Rocket Landing	97
<i>Madison V. Purcell, Alexander M. Wicklund, Nigam Vadecha</i>	

AIR AND SPACE STRUCTURAL DESIGN, ANALYSIS, TEST

Strain Allowable Criteria Discussion and 17-4PH, H1025 Flow Curve Development	113
<i>Kiernan F. Ryan, Larry S. Hernandez</i>	
Rapid Design and Analysis of a Payload Mass Simulator Using Digital Tools for Manufacturing Instructions	126
<i>Sebastian Vargas, Mason Hickman, Leland Shimizu, Jordan Fuse, Jacob Rome, Vinay K. Goyal</i>	
Unified Longeron-Stringer Design for Cost-Effective and Efficient Structural Airframes for Collegiate Liquid Sounding Rockets	141
<i>Ethan C. Quan, Edward Z. Yu</i>	
Structural Analysis of Load-Bearing Components in Mars Science Helicopter	173
<i>Dorcas Kaweesa, Joshua Bowman</i>	

Integrated Structural Design and Analysis Applied to a Large Surveillance Drone	196
<i>Jens de Boer, Arianna Bosco, Elias Allegaert, Alban Carpentier, Vasiliki Aspasiou</i>	
Stability Analysis Considerations for Geometrically Imperfect Cylinders under Thermomechanical Loads	213
<i>Sean P. Engelstad, Emily Zeitunian, Vinay K. Goyal, Brian J. Burke, Graeme Kennedy</i>	

IN-SPACE SERVICING, ASSEMBLY AND MANUFACTURING (ISAM) I

Ground Testing of Spacecraft Attitude Dynamics During In-Space Assembly and Manufacturing	224
<i>Harsh G. Bhundiya, Zachary C. Cordero, Michael A. Marshall, Swati Mohan, David Sternberg, Kevin Lo</i>	
In-Space Assembly of Large Mesh Reflectors	239
<i>Jong-Eun Suh, Sahangi P. Dassanayake, Sergio Pellegrino</i>	
Development of In-Space Assembled Tubular Masts	251
<i>Blake Fardulis, Trey Quiller, Alexi S. Rakow</i>	
Kresling Origami-Inspired Structures: Exploring Structure Types, Applications, Properties, and Analysis Methods	263
<i>Hadi Ebrahimi Fakhari, Juan Rosario Barboza, Sepehr Faridmarandi, Pezhman Mardanpour</i>	

AI/ML IN STRUCTURES AND MATERIALS II

Application of Deep Learning for Defect Detection by X-Ray Computed Tomography in Large Aerospace Structures	291
<i>Abdullah Metiner, Yuri Nikishkov, Mustafa T. Kocyigit, andrew makeev</i>	
Comparative Analysis of Synthetic Microstructure Reconstruction for Metallic Aerospace Alloys With Generative Networks	306
<i>Zekeriya Ender Eger, Waris Khan, Kuang Kuang, Veera Sundararaghavan, Pinar Acar</i>	
Fusing Imbalanced Data via Physical Condition-Aware Surrogate Modeling	319
<i>Yulun Wu, Yumeng Li</i>	

COMPOSITE STRUCTURAL ANALYSIS, DESIGN, TESTING, AND MANUFACTURING I

Structural Sizing of a Tow-Steered Truss-Braced Wing Box Test Article	330
<i>Brian H. Mason, Erin K. Anderson, Alana Cardona, Christine V. Jutte, Richard A. Larson</i>	
Improvements to Stitching Controls for Manufacturing Advanced Stitched Composites	347
<i>Andrew E. Lovejoy, Tyler Sprague</i>	
Investigation of Effects of Delamination on Buckling Behavior for Filament-Wound Cylindrical Shells	361
<i>Emre Özaslan, Ali Yetgin, Bülent Acar, Emre Kütükçeken</i>	
Enhanced Energy Absorption of an Eccentric Re-Entrant Arrowhead Structure.....	369
<i>Jose D. Villegas Hernandez, Eric Lee, Masoud Yekani Fard</i>	

AI/ML IN STRUCTURES AND MATERIALS I

Optimizing Aerospace Engineering: A Machine Learning Strategy for Accelerated Structural Substantiation	380
<i>Yuval Freed, Maoz Koren, Boris Dorfman</i>	
Probabilistic Fatigue Life Prediction of AM-Built Alloy Using Physics-Guided Neural Network	390
<i>Rakesh Balamurugan, Jie Chen, Changyu Meng, Yongming Liu</i>	
Deep-Learning-Based Optimization of Non-Periodic Porous and Composite Materials for Aerospace Structures	401
<i>Saltuk Yildiz, Zekeriya Ender Eger, Pinar Acar</i>	
Defect Detection During Composite Processing Using Machine Learning Methods	414
<i>Pragathi Agraharam Chan, Deepak Kumar, Yongxin Liu, Sirish Namilae</i>	

IN-SPACE SERVICING, ASSEMBLY AND MANUFACTURING (ISAM) II

The COSMIC Capstone Challenge	421
<i>Joseph H. Heying, Jacob Rome</i>	
Conceptual Development Design Challenge of On-Orbit Autonomous Manufacturing Payloads	430
<i>Vijay Goyal, Cindy B. Aguilar, Hunter O'Neal, Connor Talley</i>	
Autonomous Rail Transportation Network for Spacecraft Servicing and Inspection	454
<i>Erik S. Lovekin, Ali Kattee, Rahul D'Souza, Eesa Khan</i>	
Concept Development for Autonomous In-Space Additive Manufacturing, Inspection Using Thermography, and Robotic Manipulation	486
<i>William A. Sulprizio, Rogelio Reynoso, Erek Flores, Noah Liu, Joshua Santiago</i>	
NASA's Exploration and In-Space Services (NExIS) Division OSAM-1 Propellant Transfer Subsystem Progress Through FY 2024	502
<i>Brian Nufer, Thomas Aranyos, Graham Webster, Peter Knudtson, Amy Felt, Syrus Jeanes</i>	
Theoretical Model for Screen Channel Liquid Acquisition Devices With Varying Areas for In-Space Propellant Management	539
<i>Cole Millett, Vinicius Maron Sauer, Samuel R. Darr, Matthew E. Taliaferro</i>	

COMPOSITE STRUCTURAL ANALYSIS, DESIGN, TESTING, AND MANUFACTURING II

Vibration Analysis of Tow-Steered Laminates Considering Overlaps/Gaps Identified From Image Processing	549
<i>Md Raqibul Hasan Prince, Soumik Dutta, Wei Zhao</i>	
Performance Evaluation of an As-Built Composite Component Fabricated by Automatic Fiber Placement	572
<i>Jim Lua, Rui Li, Anand Karuppiah, Supun Kariyawasam, Quinten Albrecht</i>	
Lessons Learned, Best Practices, and Key Tests for Composites Pressurized Structures in Spaceflight Systems	583
<i>Vinay K. Goyal, Brett Soltz, Jesse Waller, Chad Foerster</i>	

STRUCTURAL HEALTH MONITORING AND NON-DESTRUCTIVE EVALUATION I

A Model-Informed Approach to Robust Calibration of Experimental Guided Wave Modes with Cyberphysical Systems.....	592
<i>Anirudh Gullapalli, Taha Aburakhis, Carol Featherston, Rhys Pullin, Abhishek Kundu</i>	
Defect Imaging With Frequency Domain Least-Squares Reverse Time Migration Using Analytical Green's Functions.....	608
<i>John D. Day, Weihua Su, Jeffrey Shragge, Gavin Dao</i>	
Evaluation of SMART Layer Sensor Inspection for Cracking Around Chemical Milled Area Under Simulated Environment for Commercial Airplane	626
<i>Amrita Kumar, Susheel Yadav, Danielle Stephens, Paul Swindell, David Piotrowski</i>	
Quantification of Lamb Wave-Based SHM Technique Through Ground Test Under Simulated Flight Environment for Commercial Airplane.....	637
<i>Pu Xie, Susheel.k Yadav, J.B. Ihn, Ben Lee, Fu Kuo Chang, Zeb Tidwell</i>	

STRUCTURES AND MATERIALS IN EXTREME ENVIRONMENTS

Micrometeoroid Impact Detection on Lunar Structures: A Peridynamics Approach.....	650
<i>Bala P. Shanmugam, Gary D. Seidel</i>	
Interface Detection for Fluid-Structure Interaction Modeling With Material Failure and Fragmentation.....	662
<i>Ugur Can, Monal Patel, Manuel Viqueira-Moreira, Christoph Brehm, Ibrahim Guven</i>	
Size-Dependent Thermomechanical Contact Analysis via Boundary Element Formulation.....	675
<i>Ali Reza Hadjesfandiari, Li Lin, Saptarshi Bandyopadhyay, Gary F. Dargush</i>	
Launchable Lunar Anchors.....	690
<i>Kalind Carpenter, Saptarshi Bandyopadhyay, Hannah Stuart, Ashish Goel, Scott Moreland, Christine Gebara, Elizabeth Jens, Benjamin Hockman</i>	

FATIGUE, FRACTURE, AND IMPACT DAMAGE OF STRUCTURES II

Effect of Ply Stacking Sequence in Bearing Failure of Hybrid Metal-CFRP Laminate Bolted Joints	698
<i>Rohit R. Madke, Jeron Rollins, Eric U. Maravilla, Satchi Venkataraman</i>	
HIMEX: A Hybrid Implicit-Explicit Analysis Platform for Progressive Damage Modeling of Composite Materials.....	715
<i>Shiyao Lin</i>	

VOLUME 2

Modified Four-Point Bending Test Configuration for Fracture Characterization of High Temperature Materials.....	726
<i>Leland Shimizu, James Ratcliffe, Waihong Tai, Vinay K. Goyal, Heather Hickman</i>	
Assessing the Performance of Flexible Miura-Ori Cylinders in Prolonging Structural Fatigue Life	737
<i>Hadi Ebrahimi Fakhari, Pezhman Mardanpour</i>	

Simultaneous Application of DIC and DVC Techniques for Characterizing Progressive Failure in Carbon Fiber-Reinforced Composite.....	761
<i>Chaeyoung Hong, Wooseok Ji</i>	

Numerical Investigation of Ply Termination Techniques for Delamination Suppression	766
<i>Firat Ergin, Altan Kayran</i>	

IN-SPACE SERVICING, ASSEMBLY AND MANUFACTURING (ISAM) III

Toward a Fully Capable In-Space Manufacturing Ecosystem.....	774
<i>Matthew B. Obenchain, Alex Trujillo, Jacob Rome, Joseph H. Heying, Arianna Villegas, Vinay K. Goyal, Deneen Taylor</i>	

Low Power Multi-Mode In-Space Metals and Composites Joining	794
<i>Pu Han, M Faisal Riyad, Shams Torabnia, Nathan Fonseca, Neel Garde, Keng Hsu</i>	

Space Servicing, Mobility, and Logistics (SML) Technology for the United States Space Force (USSF) Update	801
<i>Elozor Plotke, Roberta M. Ewart, Alexander Jehle, Jocelle Rudico, Gene Rogers</i>	

Establishing An In-Space Joining Ecosystem at NASA Marshall Space Flight Center via Laser Beam Welding	819
<i>Andrew O'Connor, Jonathan M. Bonebrake, Thomas C. Bryan, Zachary S. Courtright, Charles T. Cowen, Ellis R. Crabtree, William C. Evans, Emma K. Jaynes, John C. Ivester, Louise S. Littles, Christopher S. Protz, Benjamin L. Rupp, Parker D. Shake, Raju Subedi, Jeffrey W. Sowards</i>	

Robotic systems and End-effectors for ISAM Operations: A Critical Review	839
<i>Tanvi B. Arey, Salil Bapat, Ajay P. Malshe</i>	

INTEGRATED COMPUTATIONAL MATERIAL ENGINEERING (ICME)

Inverse Design of Snap-Through Multiscale Lattice Structures.....	862
<i>Charlie Aveline, Dilaksan Thillaithevan, Robert Hewson, Matthew J. Santer</i>	

Application of CUF for the Structural Optimization of Wings.....	876
<i>Donato Cardone, Rauno Cavallaro, Andrea Cini, Marco Petrolo, Enrico Zappino</i>	

Design of Functionally Graded Inconel 718 Alloy Structures by Developing Material Property Closures	896
<i>Md Maruf Billah, Pinar Acar</i>	

Shape Optimization of Porous Electrode Batteries.....	913
<i>Murtaza Bookwala, Alexandre T. Guibert, Filippo Agnelli, Alicia A. Kim</i>	

Microstructural Uncertainty Propagation Over Meso and Macro-Scale Mechanical Properties of Aerospace Metallic Alloys	927
<i>Waris Khan, Md Maruf Billah, Pinar Acar</i>	

STRUCTURAL HEALTH MONITORING AND NON-DESTRUCTIVE EVALUATION II

Detection of Damage in the Presence of Multi-Modal Loading from EIT Data Using a Source Separation Algorithm.....	940
<i>Laura Homa, Tyler Tallman, Norman Schehl, Tyler Lesthaeghe, Mark Flores, John Wertz</i>	

Ultrasound Computed Tomography With Full Waveform Inversion for Characterizing of Post-Processed Additively Manufactured Components	948
<i>Md Aktharuzzaman, John D. Day, Weihua Su</i>	
Integrating Machine Learning and Simulation for Composite Damage Detection Within a Digital Twin Framework	968
<i>Linqi Zhuang, Junyan He, Shun Xi</i>	
A Deep Learning Framework for Guided Wave-Based Structural Health Monitoring of a Composite Plate	975
<i>Kamal K. Prajapati, Akshay Rai, Agam Sharan, Sumanth Yegurla, Anup Ghosh, Mira Mitra</i>	
Fatigue Damage Detection and Classification for Composite Structures Using Variational Autoencoder and Support Vector Regression	981
<i>Hyeonho Hwang, Aditi Chattopadhyay</i>	

IN-SPACE SERVICING, ASSEMBLY AND MANUFACTURING (ISAM) IV

Accelerating Orbital Manufacturing Through In-Space Technology Experiments	991
<i>Jacob Rome, Vinay K. Goyal</i>	
12U In-Space 3D Printer Concept	1003
<i>Randy L. Spicer, Tom Cote, Tom Itchkawich, Jonathan Black, Christopher Williams, Kevin Shinpaugh</i>	
Autonomous Execution of Insertion Operations in Space Assembly Tasks	1013
<i>Abhay Negi, Nikita Sarawgi, Dhanush Penmetsa, Hantao Ye, Omey Manyar, Ashtin Cheng, Satyandra Gupta</i>	
Concept Development for In-Space Inspection of Bonded Joints Using Guided Waves and Thermography	1029
<i>Sharveny Parthibhan, Omar Palacios, Joshua Santiago, Christoph Schaal</i>	
Metal AM Using Vibrational Resonance In-Space via Cold-Welding	1038
<i>Keng Hsu</i>	

TOPICS IN AIR AND SPACE STRUCTURES I

Lightweight Low-Cost Multifunctional Composite for Structure	1044
<i>Robert A. Haynes, Harry R. Luzetsky, Ellen M. Phifer</i>	
Microstructure Characterization of Mechanically Recycled LM-PAEK Thermoplastic Composites	1061
<i>Minsu Park, Wooseok Ji</i>	
Flame Retardancy of Additively Manufactured Continuous Carbon Fiber Reinforced ABS Composites With Expandable Graphite Coating	1065
<i>Sida Xu, Zefu Ren, Zhuoyuan Yang, Nicholas Reed, Rishikesh Srinivasaraghavan Govindarajan, Daewon Kim, Yizhou Jiang</i>	
Flatwise Tensile Strength of One-Sided Stitched Composites	1077
<i>Addyson Wheat, Aditya K. Shah, Rani Sullivan</i>	
Manufacturability of PRSEUS Panels for a Mechanically Joined Wing Box	1087
<i>Shuvam Saha, Myles Baker, Rani Sullivan, Brent Scheneman, Akim Rayskiy</i>	

BUCKLING AND STABILITY OF AIR AND SPACE STRUCTURES

Axial Compressive Response of Thin Polygonal Shells: Computational Study and Experimental Validation	1101
<i>Vishwa Mohan Tiwari, Colin S. Hunter, Avinkrishnan A. Vijayachandran, Royan J. D'mello, Anthony M. Waas</i>	
Considering Buckling in Topology Optimization for Aerospace Applications.....	1111
<i>Jason Action, Benjamin Gajus, Anton Jurinic, Claus Pedersen</i>	
Buckling Tests of Cylindrical Composite Shells in Multiaxial Loading	1127
<i>Stefan Panek, Niklas Reuter, Tobias S. Hartwich, Benedikt Kriegesmann, Dieter Krause</i>	
Buckling Optimization of Isotropic Plate With Variable Stiffness	1141
<i>Sandesh Amgai, Paul Davidson</i>	

TOPICS IN AIR AND SPACE STRUCTURES II

Structural Analysis, Modeling, and Testing of Multi-Nut Joint for TriTruss Structure	1157
<i>Kyongchan Song, Brace White, Ray Shimry Garatsa, Olive R. Stohlman</i>	
Analytical Solution for the Displacement Field in Composite Single-Lap Shear Joints With Zero-Thickness Interfaces	1171
<i>Arne Schiller, Saullo G. Castro, Chiara Bisagni</i>	
Novel Hybrid Joining and Performance Evaluation for Composite Components	1184
<i>Jim Lua, Rui Li, Mark Walthers, Brandt Walthers</i>	
Thermo-Structural Dynamics of the CROME Propulsion System: A Preliminary Study.....	1197
<i>Salvador Orozco Martinez, Iram Hernandez, Md Amzad Hossain, Ahsan Choudhuri</i>	

AI/ML IN STRUCTURES AND MATERIALS III

Physics-Informed Machine Learning Model for Ceramic Matrix Composite Creep.....	1215
<i>Mohamed Hamza, Luke Borkowski, Aditi Chattopadhyay</i>	
Efficient Estimation of Hierarchical Honeycomb Mechanical Properties by a Knowledge-Extraction-Based Surrogate Model	1230
<i>Fakhreddin Emami, Md. Amanullah Kabir Tonmoy, Chadwick D. Severt, Andrew J. Gross, Yi Wang</i>	
A Physics-Informed Neural Network Based Modelling of Vibration of a Beam With Breathing Crack	1242
<i>Sumanth Yegurla, Bhavana Bollarapu, Mira Mitra</i>	
A Convolutional Neural Network for Enhancement of Multi-Scale Localization in Fiber-Reinforced Polymer Matrix Composite Representative Unit Cells.....	1247
<i>Cristian Sanchez, Evan J. Pineda, Brandon L. Hearley, Joshua Stuckner, Trenton M. Ricks, Peter A. Gustafson</i>	

COMPOSITE STRUCTURAL ANALYSIS, DESIGN, TESTING, AND MANUFACTURING III

New Stress-Driven Reissner Mixed Variational Theorems for an Enhanced Transverse Stress Response in Composite Structures.....	1271
<i>Michele D'Ottavio, Luciano Demasi</i>	
Results and Findings From the Organic Matrix Composites Process-to-Performance, Evaluation, Research and Analysis (OPPERA) Program	1308
<i>David S. Riha, Matthew Kirby, Marcus L. Stanfield, Vikram Bhamidipati, Carl F. Popelar, Eric G. Zhou, Alireza Forghani, Endel Iarve, Kevin Hoos, Alex S. Selvarathinam, Michael Ballard, David Mollenhauer</i>	
Sensitivity Analysis of Laminated Thin Ply Laminated Carbon Composites	1330
<i>Thomas Neigh, Rakesh K. Kapania, Thomas McQuigg</i>	

AI/ML IN STRUCTURES AND MATERIALS IV

A Computationally Efficient Abstract Model for Capturing the Nonlinear Response of Bolted Joints.....	1350
<i>Aditya B. Bansod, P. M. Anilkumar, Sven Scheffler, Raimund Rolfes</i>	
Failure Prediction of the Three-Dimensional Woven Composite Wing Box by Deep Shapley Additive Explanation.....	1360
<i>Yeonhi Kim, Jungsun Park</i>	
Discovery of High-Entropy Ultra-High Temperature Ceramics Through Neural Networks	1368
<i>Matthew Arviso, Enrique A. Bermudez, Alejandro F. Ornelas, Alejandra G. Castellanos</i>	

FATIGUE, FRACTURE, AND IMPACT DAMAGE OF STRUCTURES III

Simulation of Non-Planar Spall Under Hypervelocity Impact	1381
<i>Basim Qamar, Nathan R. Barton, Amine Benzerga</i>	
Analytical Methodology, Test Methodology, and Requirements for Spaceflight Bellows	1391
<i>Vinay K. Goyal, Brett Soltz, Christopher N. Sagrillo, Daniel Ortiz, Leland Shimizu</i>	
Experimentally Validated Multiscale Fatigue Model for Fiber-Reinforced Polymer Composites	1405
<i>Jose F. Rojas Sanchez, Anthony M. Waas</i>	
High Energy Impact Analysis of Heat Treated IN718 Specimens.....	1409
<i>Katie Bruggeman, Anthony N. Palazotto, Daniel Young, John Hansen</i>	
Proposed Reliability-Based Damage Tolerance Guidelines for Space Systems	1416
<i>Leland Shimizu, Vinay K. Goyal, Deneen Taylor, Christopher Trautner</i>	
Validation and Sensitivity Study of 3D FEA Based Solutions Against Two Sets of Marker Bands Recorded in Fatigue Crack Growth Measurement	1426
<i>Adrian Loghin</i>	

Author Index