American Society of Civil Engineers

10th Biennial ASCE International Conference on Engineering, Construction, and Operations in Challenging Environments

Earth and Space 2006

March 5-8, 2006 Houston, Texas, USA

Volume 1 of 3

Printed from e-media with permission by:

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

ISBN: 978-1-60423-509-8

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

Notices

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document.

ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefore. This information should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing this information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

Copyright © 2006 by the American Society of Civil Engineers. All Rights Reserved.

Manufactured in the United States of America.

American Society of Civil Engineers ASCE International Headquarters 1801 Alexander Bell Drive Reston, VA 20191-4400 USA

Call Toll-Free in the U.S.: 1-800-548-2723 (ASCE) Call from anywhere in the world: 1-703-295-6300 Internet: http://www.pubs.asce.org American Society of Civil Engineers

10th Biennial ASCE International Conference on Engineering, Construction, and Operations in Challenging Environments 2006

Table of Contents

Volume 1

Advanced Aerospace Systems Aerospace Structures, Quantitative Methods

- 1 Probabilistic Structural Evaluation of Uncertainties in Radiator Sandwich Panel Design
 - Latife Kuguoglu and Damian Ludwiczak
- 9 Sensor Placement for Aerospace Vehicle Health Monitoring Systems R. F. Guratzsch and S. Mahadevan
- 17 Acoustic Testing of Hollow Core Fairing Designs John Higgins, Andrew Williams, and Emil V. Ardelean
- 25 Design of "Assessment and Decision Aiding Software for Application in High Risk Fields" with a Case Study: The Challenger Tragedy R. Cocks, A. Gutierrez, D. Berich-Henry, T. Weber, L. Rodenbeck, and S. Lingard
- 33 Wind Tunnel Investigation of Grid Finned Missile Configuration over Planar Control Surfaces

K. Sivaprakaash and K. M. Parammasivam

Deployable Structures I

- A New Design Variant of the Large Deployable Space Reflector E. Medzmariashvili, Sh. Tserodze, N. Tsignadze, M. Sanikidze, L. Datashivili, A. Sarchimelia, K. Chkhikvadze, N. Siradze, and G. Bedukadze
 Mambrana and Thin Shalla for Space Pefloaters
- 48 Membrane and Thin Shells for Space Reflectors L. Datashvili and H. Baier
- 56 Dynamic Characterization for Multi-Layer Membrane Space Altimeter J. C. Heald and A. Pointel

Deployable Structures II

- 64 SAR Membrane Tensioning M.-J. Potvin and J. C. Heald
- 72 Numerical Simulations of a Deployable Structure Tang-Tat Ng
- 78 Cable Vibration Control with a Magnetorheological Fluid Based Tuned Mass Damper W. J. Wu and C. S. Cai

Dynamics and Controls of Aerospace Structures

- 86 Lumped and Distributed Parameter Models of a Spacecraft with Elastic Appendages: Exact Frequencies and Mode Shapes Joel A. Storch
- 94 Effect of Wall on Mixing of Low Speed Multiple Rectangular Jets G. Mahendra Perumal and B. T. N. Sridhar
- 104 Experimental and Computational Studies on Delta Wing Configurations with Different Leading Edge Profiles
 M. Gopinath and K. M. Parammasivam

Enabling Technologies for Space Exploration and Transportation

- **114** Infrared Aircraft Deicing System Henry W. Hessing
- **120** Space Power Grid—Evolutionary Approach to Space Solar Power N. Komerath, N. Boechler, and S. Wanis
- **125** Accuracy Requirements for Cannon-Launched Space Missions P. T. Putman, S. J. Scruggs, Y. X. Zhou, H. Fang, and K. Salama
- **133 Preliminary Mission Study: Mass Driver for Earth-Bound Asteroid Threat Mitigation** Cole K. Corbin and John E. Higgins

Granular Materials in Lunar and Martian Exploration (The 2nd Workshop) Cratering

- **141** Cratering by a Subsonic Jet Impinging on a Bed of Loose Particles Robert B. Haehnel, Benoit Cushman-Roisin, and W. Brian Dade
- **149** Functional Scaling for the Cratering of a Granular Surface by an Impinging Jet C. M. Donahue, P. T. Metzger, and C. D. Immer

Granular Flow

- **155 Particle-to-Particle Interaction during Shearing of Granular Materials** Bashar A. Alramahi and Khalid A. Alshibli
- **163** Contrasting Terrestrial and Lunar Gravity: Angle of Repose and Incline Flows S. Ji and H. H. Shen

Lunar and Martian Dust, Modeling and Mitigation

- **171** Image-Based Modeling of Lunar Soil Simulant for 3-D DEM Simulations Takashi Matsushima, Jun Katagiri, Kentaro Uesugi, Akira Tsuchiyama, and Tsukaka Nakano
- **179** Charged Dust Dynamics near the Lunar Surface J. E. Colwell, S. R. Robertson, M. Horányi, X. Wang, and P. Wheeler
- 184 A Layered Architecture for Mitigation of Dust for Manned and Robotic Space Exploration

Frederick A. Slane and Gary Rodriguez

192 Lunar Simulants as Feedstocks for ISRU Processing: Mineralogy and Chemistry E. Hill, A. D. Patchen, B. Deane, Y. Liu, J. Park, and L. A. Taylor

200 Submicron Particle Size Distribution of Apollo 11 Lunar Dust J. Park, Y. Liu, K. D. Kihm, E. Hill, and L. A. Taylor

Modeling Issues for Granular Material

- **206** Micromechanical Modeling of the Interaction of a Soil-Rigid Wheel System Claudia Medina and Mourad Zeghal
- 214 Footprints: The Role of Particle Characteristics Hyun-Ki Kim and J. Carlos Santamarina

Modeling Methodology

- **221** AModel for Large Scale Near-Real Time Simulation of Granular Material Flow E. G. Nezami, Y. M. A. Hashash, and J. Ghaboussi
- 229 Injecting Particle Scale Physics into Continuum Models of Granular Materials for Large-Scale Applications

S. D. C. Walsh and A. Tordesillas

237 On the Behavior of Granular Materials in Rough Wheel Contacts on Mars C. Fred Higgs III, Venkata Jasti, Christopher Racusen, Courtney Heller, Nadav Cohen, and John Tichy

Property Measurements, Computational

- 245 Multiscale Analysis of the Effects of Changing Gravity on Stress Propagation in a Material Subject to an Indenting Rigid Flat Punch Maya Muthuswamy and Antoinette Tordesillas
- 253 Evolution of Contact Forces, Fabric, and their Collective Behavior in Granular Media under Deformation: A DEM Study J. T. Bosko and A. Tordesillas
- 261 Simulation of Agglutinates Formation Chotipong Somrit and Masami Nakagawa
- 268 Determination of Axial Stress and Deformation Variations in a Cylindrical Bed of Granular Material with Applications in Space Ramesh B. Malla and Ganesh Anandakumar

Property Measurements, Experimental

- 277 Cam Cap Models for Lunar Soil: A First Look Richard A. Schultz
- **284** Morphology and Physical Characteristics of Apollo 17 Dust Particles Y. Liu, J. Park, E. Hill, K. D. Kihm, and L. A. Taylor
- **290** Lunar Regolith Geotechnical Properties: Implications for Exploration S. N. Batiste and M. R. Lankton

Structure/Machine/Tool–Soil Boundary

297 Concept of Virtual Soil Bin by DEM for Lunar Locomotion Studies Hiroshi Nakashima, Shigeru Aoki, Hiroshi Kanamori, and Akira Oida

305 How to Swim in Sand M. Bzdega and S. A. Koehler

Human Exploration and Development of Space Advanced Life Support Systems I

 313 Abiotic Ammonia Mass Transfer in a Biotrickling Filter Eric McLamore, Sybil Sharvelle, Kathy Banks, and Stephen Clark
322 Macro- and Micro-Scale Contaminant Removal and Resource Recovery from Urine via the Freeze Concentration Process

J. M. Schmidt and J. E. Alleman

330 Thermophilic Aerobic Solid Waste Processing for Long-Term Crewed Missions D. R. Whitaker and J. E. Alleman

Advanced Life Support Systems II

338 Treatment of an Early Planetary Base Wastestream in a Rotating Hollow Fiber Membrane Reactor

Tony Rector, Jay Garland, Kristina Reid-Black, Richard F. Strayer, Mary Hummerick, Mike Roberts, and Lanfang Levine

344 A Novel Membrane Bioreactor for Spacecraft Water Recycling Daniel Smith, Jay Garland, and Tony Rector

Exploration and Utilization of Space

- **350** Returning to the Moon: Resources, Future Development, and Colonization Tapan R. Kulkarni, Mukul M. Agnihotri, and Shantanu C. Prabhune
- **357 Space Traffic Control Mission Assurance** Michael H. Elder
- **365** A Lunar Miner Design: With Emphasis on the Volatile Storage System Matthew E. Gajda, Gerald L. Kulcinski, Gregory I. Sviatoslavsky, and Igor N. Sviatoslavsky
- **373** Asteroid/Comet Classification for Mining Purposes Leslie Sour Gertsch, John L. Remo, and Richard Gertsch

Multiphase Flow in Space Exploration Systems

- **381 Bubbles and Droplets in Tubing in Reduced Gravity** Steven H. Collicott
- **389** Fundamental Characteristics of Granular Flow Under Variable g-Levels Richard M. Lueptow, Tim Arndt, Antje Brucks, and Julio M. Ottino
- 394 Two Phase Flow Analysis on Filling Processes of Microfluidic/Microarray Integrated Systems B. Johnson C. P. Chen A. Jenkins, S. Spearing, J. A. Monaco, A. Steele

B. Johnson, C. P. Chen, A. Jenkins, S. Spearing, L. A. Monaco, A. Steele, and G. Flores

Space Engineering and Construction

- **400 Curing of Surfaces Formed by Tailored Force Fields** S. Wanis and N. Komerath
- 405 "All Up" Analog Simulations: Why They are Essential for Planning Long Duration Human Missions to the Moon and Mars Cathy Dankewicz, Ruthan Lewis, and Kurt A. Micheels

Space Business, Commerce, Tourism, and Law

- 413 Space Commerce and Space law: Making the Twain Meet Debarupa Banerjee
- 421 Crossing the Infinite Frontier: An Analysis of Property Rights Regime in Corpus Juris Spatialis Ketan Mukhija
- 429 Public Attitudes Toward Different Space Goals: Building Public Support for the Vision for Space Exploration (VSE) Thomas L. Matula and Karen A. Loveland

Volume 2

Lunar and Martian Bases and Exploration (LMBE) Advanced Concepts for Habitat and Exploration

- 436 The Surface Endoskeletal Inflatable Module (SEIM) Constance M. Adams and Georgi Petrov
- 444 Advantages of Modularity and Commonality in a Spacecraft Architecture Kenneth Smith
- **450** Analysis of a 3D Frame—Membrane Structure for Lunar Base Ramesh B. Malla and Damayanti Chaudhuri
- 458 Growth in Reticulated Undulating Biospheres: A Model for Flexible Initial Deployment Greenhouse Systems for Lunar and Martian Exploration J. M. Maze

Instruments, Sensors, and Techniques to Characterize Planetary Regolith

465 A Proposal for Estimating Strength Parameters of Lunar Surface from Soil Cutting Resistances

T. Kobayashi, H. Ochiai, R. Fukagawa, S. Aoki, and K. Tamoi

473 Test Results of Core Drilling in Simulated Ice-Bound Lunar Regolith for the Subsurface Access System of the Construction and Resource Utilization eXplorer (CRUX) Project

K. Zacny, P. Bartlett, K. Davis, D. Glaser, and S. Gorevan

481 Neutron Probes for the Construction and Resource Utilization eXplorer (CRUX) R. C. Elphic, S. Hahn, D. J. Lawrence, W. C. Feldman, J. B. Johnson, and A. F. C. Haldemann

Lunar and Martian In-Situ Resource Utilization

- **489** Microwave Processing Apollo Soil: Products for a Lunar Base L. A. Taylor, E. Hill, Y. Liu, J. Park, and R. W. Bruce
- **497** Microwave Induced Carbothermic Reduction of Iron Oxides in Lunar Soil Simulant Dustin G. Temple, Matthew T. Goff, Jeffrey D. Martin, David Agresti, and Walter W. Boles

503 Data Fusion Methods Applied to the Construction and Resource Utilization explorer (CRUX) Instruments to Characterize Regolith Hydrogen Resources Jerome B. Johnson, Albert F. C. Haldemann, Richard C. Elphic, William W. Boynton, John Wetzel, and Hannah Jensen

Lunar and Martian Habitats Utilizing In-Situ Resources

- **511 Development and Application of Lunar "Concrete" for Habitats** H. Toutanji, M. R. Fiske, and M. P. Bodiford
- 519 Lunar In Situ Materials-Based Habitat Technology Development Efforts at NASA/MSFC M. P. Bodiford, K. H. Burks, M. R. Perry, R. W. Cooper, and M. R. Fiske
- **527 Optimal Evolutionary Computational Parameters for Habitat Structures Optimization** Patrick V. Hull, Michael SanSoucie, Gerry Dozier, and Mike Tinker
- 535 Inflatable and Deployable Structures for Surface Habitat Concepts Utilizing In-Situ Resources

Mike Tinker, Patrick V. Hull, Michael P. SanSoucie, and Angel Roldan

543 Meteoroid Risk Assessment of Lunar Habitat Concepts Steven W. Evans, Roderick Stallworth, Jennifer Robinson, Robert Stellingwerf, and Erich Engler

Lunar/Mars H₂O Resource Potential and Proposed H₂O Extraction Techniques

- 551 Accessible Water on Mars and the Moon
- Donald Rapp, Greg S. Mungas, Robert W. Easter, and Kenneth R. Johnson
- **562** Sublimation Extraction of Mars H₂O for Future In-Situ Resource Utilization Greg S. Mungas, Donald Rapp, Robert W. Easter, Kenneth R. Johnson, and Thomas Wilson

Numerical and Experimental Modeling of Lunar and Martian Soil Simulants

- 570 Water Release from Shaken Silica Substrates in a Catalytic Reactor X. Zhao, S. M. Stagg-Williams, and J. S. Olafsen
- **578** Discrete Element Modeling of Polyhedral Representation of Granular Materials D. Zhao, E. Nezami, Y. M. A. Hashash, and J. Ghaboussi

Lunar/Mars Mission Planning

- 587 Structures for Manned Habitation H. Benarova
- 595 Modular Facility Selection and Configuration Considerations for Lunar/Mars Surface Bases

Larry Bell

605 Operational Strategies and Capabilities for Habitation Systems in the Exploration of the Lunar Surface

Molly Anderson, Robert Howard, and Larry Toups

617 Definition and Development of Habitation Readiness Level (HRLs) for Planetary Surface Habitats

Jan Connolly, Kathy Daues, Robert L. Howard, Jr., and Larry Toups

625 Spacecraft Recovery Port Concepts Frank Eichstadt

Lunar/Mars Surface Architectures

- 631 Design Concepts for Interior Configurations of Lunar/Mars Inflatable Habitat Modules Sujata Zatakia
- 639 Lunar Surface Scenarios: Habitation and Life Support Systems for a Pressurized Rover

Molly Anderson, Anthony Hanford, Robert Howard, and Larry Toups

Planning and Concept Development

- 647 Operational Strategies and Critical Capabilities for Human Sortie Missions on the Lunar Surface John E. Gruener
- 655 AMoon is a Terrible Thing to Waste: A Case for Lunar Master Planning Susan H. Brinson and Robert A. Callahan
- 661 Application of Site Analysis to Enhance Lunar and Mars Expeditionary Base Design Cathy Dankewicz, Ruthan Lewis, and Kurt A. Micheels

Properties of Lunar Regolith and Simulants

- 667 Characterizing Granular Material Constitutive Behavior Using SelfSim with Boundary Load-Displacement Measurements
 - Youssef M. A. Hashash, Jamshid Ghaboussi, and Sungmoon Jung
- 675 Arching Prediction in Granular Materials with a Nonlinear Yield Condition Radoslaw L. Michalowski
- 683 A Review of Geotechnical Properties of Lunar Regolith Simulants S. Sture

New Frontiers in Technology Field Sensing and Robotics I

- 689 Design and Mobility Evaluation of a Crawler-Type Lunar Vehicle Sachiko Wakabayshi, Hitoshi Sato, and Kohtaro Matsumoto
- 697 Autonomous Robot for Pavement Construction in Challenging Environments Christopher Maynard, Robert L. Williams II, Paul Bosscher, L. Sebastian Bryson, and Daniel Castro-Lacouture
- 705 Mixed Reality—Enhanced Operator Interface for Teleoperation Systems in Unstructured Environment Xiangyu Wang and Phillip S. Dunston
- 713 Direction for Space Construction Robot: Challenges in the Millennium Tai Sik Lee, Saumya R. Swain, Ja Kyung Koo, and Dong Wook Lee
- 721 A Robot Supervision Architecture for Safe and Efficient Space Exploration and Operation

Ehud Halberstam, Luis Navarro-Serment, Ronald Conescu, Sandra Mau, Gregg Podnar, Alan D. Guisewite, H. Benjamin Brown, Alberto Elfes, John M. Dolan, and Marcel Bergerman

Field Sensing and Robotics II

- 729 Design and Modeling of the NU Smart Space Drilling System (SSDS) Yinghui Liu, Brian Weinberg, and Constantinos Mavroidis
- 737 Modeling Lunar Architectures Using 3D Real-Time Visualization and Simulation Bruce Damer, Dave Rasmussen, and Peter Newman
- 745 Human Assistant Planetary Exploration Robots Robert L. Hirsh, Jeffrey S. Graham, Jennifer L. Rochlis, and Henry Harris

Performance-Based Engineering in Challenging Environments

753 Controlling the Risks to the Public from the Consequences of Large Rocket Launch Failures

J. D. Collins, J. M. Haber, J. B. Baeker, and P. D. Wilde

- 761 Capability Investment Strategy to Enable JPL Future Space Missions William Lincoln, Sofia Merida, Virgil Adumitroaie, and Charles R. Weisbin
- 769 Performance-Based Engineering for Lunar Settlements Haym Benaroya
- 777 Toward System Performance Standards for Infrastructure Systems Impacted by Natural Hazards

Craig Taylor, Stuart D. Werner, and Bill Graf

Remote Sensing and Space-Based Technologies for Earth Science

785 SEDRIS: A Tool for the Management and Exchange of Multi-Domain Environmental Data

Michael J. Leite, Virginia Dobey, and Peggy Gravitz

- 793 Application of the Spatial Reference Model to Precision Coordinate Transformation Michael J. Leite and Paul Berner
- 801 Detection of Sediment Disaster Due to the 2000 Tokai Heavy Rainfall Using High Resolution Satellite Images

Makoto Kawamura, Kazuhiko Tsujino, and Yuji Tsujiko

809 Fusion and Visualization of 3D Image Elevation Data in Computer Automated Virtual Environment (CAVE)

Xiugang Li, Michael A. Stubblefield, Guoqiang Li, and H. Dwayne Jerro

Wind Engineering in Urban Planning and Design

- 816 Work of the ASCE Task Committee on Urban Aerodynamics Richard Aynsley
 822 Natural Ventilation in Residential Subdivisions
- B. Su and R. Aynsley
- 829 Wind Engineering in Large Scale Urban Design Richard Aynsely
- 836 Strategies for Natural Ventilation of Urban Office Buildings Regan Potangaroa
- 844 CFD in Urban Aerodynamics: Wind Speed Conditions in Passages between Parallel Buildings

B. Blocken, T. Stathopoulos, and J. Carmeliet

Wireless Technology in Construction

- **852** A Framework for Real-Time Construction Project Progress Tracking A. G. Ghanem and Y. A. AbdelRazig
- **860 A Survey of the Use of Wireless and Web-Based Technologies in Construction** Trefor P. Williams, Leonhard Bernold, and Huanqing Lu
- 868 Effective Processing of GPR Data to Investigate the Sub-Space Leonhard E. Bernold
- 876 Ubiquitous Communication to Link Islands of Information in Construction Leonhard E. Bernold
- 883 ISRUs on Moon and Mars Create Synergistic Interdependencies Leonhard E. Bernold and Haym Benaroya

Architecture and Engineering for Extreme Environments Architecture for Space and Extreme Terrestrial Environments

- **891** Autonomous Architecture Proposal for Summit Science Station in Greenland Olga Bannova and Ian F. C. Smith
- 900 A Low-Thrust Transportation Architecture to Transfer Crews and Cargo between Earth and Mars Orbits Michael Lamberty

Volume 3

908 Multipurpose Module for Space Explorations: Design of Hab/Lab Unit for Lunar/Mars Missions

Sowmya Balasubramani and Alejandro Colom

916 Interior Accommodations and System for Lunar and Mars Habitats: Design Innovations of the Sleeping Compartments in Mars Transfer Module Yasumasa Onishi

Concepts for Autonomous Explorations

- 921 Ascent and Earth Recentry Crew Descent Vehicle Concepts for Lunar and Mars Exploration Olga Bannova
- 928 Project Arusha: Pressurized Rover Systems Robert L. Howard, Jr., Edward W. Tunstel, Willie L. Thompson II, Horace L. Bussey, and Jennifer Scott Williams
- **936 A Mapping Balloon for Future Robotic and Human Lander Missions to Mars** Klaus Totzek, Anton Zylka, and Bernd Schäfer
- 944 A Moon-Micro-Mission (MMM) Anton Zylka, Klaus Totzek, and Bernd Schäfer

Conceptual Architecture for Space Exploration

952 Design Concepts for Space Settlements Giorgio Gaviraghi 961 A Spiral Approach for Development of Lunar and Martian Exploration Using Crew Exploration Vehicle

Tapan R. Kulkarni, Mukul M. Agnihotri, and Shantanu C. Prabhune

- 969 Kalpana One: A New Space Colony Design Ankur Bajoria, Nitin Arora, and Al Globus
- 977 Architecture for Protracted Exploration Francis X. "Duke" Kane and Sean W. Dooley

Engineering and Construction in Challenging Terrestrial Environments

- **985 Construction in Challenging Environments Using Intelligent Techniques** V. S. S. Kumar and Mir Iqbal Faheem
- **994** Investigating Subsurface Conditions in Bouldery Terrain—Lessons from the Field Philip J. Shaller
- **1002** Space Design and the Lessons of Experimental Architecture Khaled Nassar and Bakr Morad

Providing Situational Awareness for Systems Operating in Harsh, Remote Environment

1007 Technology Readiness of a Modulated Laser Analyzer of Combustion Products for the Manned Spacecraft Environment E. A. Thomas and D. M. Klaus

Structures and Materials Analysis and Design of Innovative FRP Structural Systems

- 1015 Strengthening and Rehabilitation of Concrete Structures with Carbon Fiber Reinforced Polymers (CFRP) A. Saeed, A. Shah, and A. Nadar
- 1023 Polymer Matrix Composite Panels for Seismic Energy Dissipation X. Luo and A. J. Aref
- **1032 Effectiveness of FRP Wrap for Temporary Repairs in R/C Bridge Column Applications** Sreenivas Alampalli
- **1037** Impact Response of Elastic and Elastic-Plastic Sandwich Beams Mijia Yang and Pizhong Qiao

Application of Smart Structures

- **1045** Seismic Behavior of Low-Rise Shear Walls with SMA Bars E. Effendy, W. I. Liao, G. Song, Y. L. Mo, and C. H. Loh
- 1053 Comparison of Analytical Approaches to Structural Model Updating Using Modal Test Data

Hongping Zhu and Xingzhou Hao

- **1061** Experimental Investigation on Self-Rehabilitation of Intelligent Concrete Beams Reinforced with Superelastic Shape Memory Alloys Hong-Nam Li, Di Cui, Gangbing Song, and Y. L. Mo
- 1068 Dynamic Behavior of a Two-Story Building Frame Braced with SMA for Vibration Control

Rafiqul A. Tarefder, Ning Ma, and Gangbing Song

Ballistic Impact of Composite

- 1077 Incorporation of the Effects of Temperature and Unloading into the Strain Rate Dependent Analysis of Polymer Matrix Materials Utilizing a State Variable Approach R. K. Goldberg, G. D. Roberts, and A. Gilat
- 1085 Multiscale Numerical Simulation of High-Velocity Impact on Polymer Matrix **Composite Laminates**
 - Linfa Zhu, Aditi Chattopadhyay, and Robert K. Goldberg
- 1093 AModified State Variable Polymer Model Implementation in LS-DYNA Jingyun Cheng and Wieslaw K. Binienda
- 1101 Ballistic Impact Testing of Composite Structures J. Michael Pereira, Duane M. Revilock, Jr., and William A. Arnold

Composites

- 1111 New Glass Fiber Reinforced Concrete for Extraterrestrial Application H. Toutanji, B. Schrayshuen, and Meng Han
- 1119 Investigation of Bending/Buckling Characteristics for FRP Composite Poles Nihar Desai and Robert Yuan
- 1137 Effect of Graphite Nanoplatelet Loading on the Microcrack Mitigation Capabilities of **Composite Structures**

L. A. Sasa, H. T. Hahn, and J. E. Higgins

Creative Applications of Structural Engineering

- 1145 Structural Design of a Unique Passive Telescope W. H. Gerstle, F. A. Roybal, J. T. McGraw, and W. T. Williams
- 1153 Online Actuator Failure Detection Using Direct Approach Zhiling Li and Satish Nagarajaiah

Damping and Viscoelasticity

- 1161 Next Generation Vibration Damping Materials: Route Map and Forecast M. V. Kireitseu
- 1169 Experimental Methods for the Viscoelastic Characterization of an Elastic Memory **Composite Resin**

John A. Lips and Arup K. Maji

- 1177 Performance Verification of Smart Passive Damping System Attached to Stay Cable S. W. Cho, J. S. Jo, H. J. Jung, and I. W. Lee
- 1185 Experimental Study on Torsional Response Control of Frame-Shear Wall Eccentric Structure Using MR Dampers Xiu Ling Li and Hong Nan Li

Dynamics and Controls of Structures

- 1193 Identification of Modal Parameters for Close-Mode Structures with Output-Only Data X. Feng and J. Zhou
- 1201 Control of Tuned Liquid Dampers for Wind-Induced Skyscraper Vibration Hongnam Li, Qinyang Jing, and Guoxin Wang

- 1209 High Accuracy GPS Deformation Monitoring via Errors Cancelling by ANC and Wavelet Analysis Ting-Hua Yi and Hong-Nan Li
- **1217** Conceptual Modelling of Damping of CNT-Reinforced Materials M. V. Kireitseu, L. V. Bochkareva, and G. R. Tomlinson

Infrastructure Materials

- **1225** Numerical Simulation of Aggregate Shape of Concrete Chengbin Du and Liguo Sun
- 1233 Theoretical and Numerical Study of Mechanic Performance of Asphalt Concrete Bridge Deck Pavement Jin-qiang Song, Xing-zhou Hao, and Hong-ping Zhu
- 1239 Numerical Simulation of the Uniaxial Failure of Three-Grading Concrete Based on Micro Damage Chengbin Du and Chaojun Ren
- 1247 Behavior of High Performance Concrete Exposed to Internal Sulfate Attack (Gypsum-Contaminated Aggregate) Tarig S. Al-Attar, Alaa M. Al-Khateeb, and Abid H. Bachai
- 1253 Prediction of Ultimate Shrinkage and Shrinkage Half-Time for Concrete Poured in Hot Climates: Development of the ACI 209 Committee Shrinkage Model Tariq S. Al-Attar and Ali J. Al-Jaleeli

Mechanics of Advanced Materials and Structures

- **1261** Structural Weight Optimization with Tabu Search M. Kargahi and J. C. Anderson
- **1269** Behavior of Piezoresistive Cement Based Materials Victor Y. Garas and C. Vipulanandan
- **1277 Modeling and Failure Analysis of Elastic-Plastic Sandwich Beams** Pizhong Qiao and Mijia Yang
- **1285 A New Bernoulli-Euler Beam Model Based on a Modified Couple Stress Theory** S. K Park and X.-L. Gao

Seismic Response and Considerations

1294 Long-Span Bridge Dynamic Response due to Ground Motions Considering Phase Differences

Guoxin Wang, Donglei Wang, and Dongsheng Wang

- **1302** Seismic Response of Buried Pipelines during Liquefaction Guoxin Wang, Weizheng Wang, Zhen Zhao, and Shuanghua He
- **1310 Finite Element Analysis Model of High Cycle Fatigue Damage for Metal Structure** Wei-hui Zhong and Ji-ping Hao
- 1317 Experimental Study on Aseismic Characteristics of RC Shear Walls with Diagonal Profile-Steel Bracings Shi-Yun Xiao, Hong-Nan Li, and Jing-Wei Zhang

Smart Materials

1325 Optical Fiber Grating Sensors Hong-Nan Li, Liang Ren, Dong-sheng Li, and Gang-bing Song **1333 Vibration Suppression of Flexible-Link Manipulator by PZT Actuators and Sensors** A. Davighi, M. Romano, and F. Bernelli-Zazzera

Structural Health Monitoring

- **1341** In-Situ Damage Detection of Wharf Structures Using Local Damage Factor Shanshan Wang, Qingwen Ren, and Pizhong Qiao
- **1349** Structural Health Monitoring for LRT Underground Tunnel Liner Mark Bourland and Robert Yuan
- **1357** Damage Detection Algorithms and Sensor Systems for Laminate Composite Beams Pizhong Qiao, Wahyu Lestari, Mitali G. Shah, and Jialai Wang
- 1365 Performance of Smart Peizoelectric Transducers for Structural Health Monitoring on Composite Laminates in a Wide Range of Temperature Environments K. K. Tseng, M. L. Tinker, J. O. Lasssiter, and J. T. Eckel

Author Index