

Structures Congress 2022

SELECTED PAPERS FROM THE STRUCTURES CONGRESS 2022

April 20–23, 2022
Atlanta, Georgia

SPONSORED BY
The Structural Engineering Institute of the
American Society of Civil Engineers

EDITED BY
James Gregory Soules, P.E., S.E., P.Eng



Published by the American Society of Civil Engineers

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia, 20191-4382
www.asce.org/publications | ascelibrary.org

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 therefor. The information contained in these materials should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing such information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

Photocopies and permissions. Permission to photocopy or reproduce material from ASCE publications can be requested by sending an e-mail to permissions@asce.org or by locating a title in ASCE's Civil Engineering Database (<http://cedb.asce.org>) or ASCE Library (<http://ascelibrary.org>) and using the "Permissions" link.

Errata: Errata, if any, can be found at <https://doi.org/10.1061/9780784484180>

Copyright © 2022 by the American Society of Civil Engineers.
All Rights Reserved.
ISBN 978-0-7844-8418-0 (PDF)
Manufactured in the United States of America.

Preface

The Structures Congress has a robust technical program for Structural Engineers focusing on topics important to practitioners, academics and researchers at all levels of their career. The papers submitted for publication in the proceedings represent some of the topics covered in the technical program but not all. For details on all the sessions held at the congress look on the conference website www.structurescongress.org

The papers in the proceeding are on the following topics

- Blast & Impact Loading & Response of Structures
- Bridges, Tunnels, and other Transportation Structures
- Buildings
- Business and Professional Practice
- Education
- Forensic
- Natural Disasters
- Nonstructural Components and Systems
- Innovative Research

Acknowledgments

Preparation for the Structural Engineering Institutes (SEI) Structures Congress required significant time and effort from the members of the National Technical Program Committee, the keynote and Special Session working group and staff. Much of the success of the conference reflects the dedication and hard work by these volunteers.

The SEI National Technical Program Committee and staff would like to acknowledge the critical support of the sponsors, exhibitors, presenters, and moderators who contributed to the success of the conference through their participation.

Thank you for spending your valuable time attending the Structures Congress. It is our hope that you and your colleagues will benefit greatly from the information provided, learn things you can implement and make professional connections that last for years.

Sincerely,

J. G. (Greg) Soules, P.E., S.E., P.Eng, F.SEI, F.ASCE
CB&I Storage Solutions
Chair, National Technical Program Committee

Contents

Blast and Impact Loading

Analysis of Impact-Induced Fracture of Laminated Glass Using Multi-Objective Genetic Algorithm	1
Moheldeen Hejazi, Mesut Kucuk, and Ali Sari	
Deep Neural Network (DNN) Model to Predict Close-In Blast Load	10
David Holgado, Arturo Montalva, Jason Florek, Khaled El-Domiaty, and Bryan Calidonna	
Development and Validation of an Inertial Vehicle Barrier Calculator	26
Tyler W. Norman, Jeffrey P. Nielsen, and James S. Davidson	
Heavy Goods Truck: Can We Stop It?	39
Ashish Bhargava and Yousef Alostaz	
How Should I Design My Blast Resistant Glazing Connections?	48
Joseph Harijanto and Ross Cussen	
Predicting Fragment Velocity of Masonry Walls Subjected to Blast.....	60
John E. Hatfield, Genevieve L. Pezzola, Robert E. Walker, John M. Hoemann, Catherine S. Stephens, and James S. Davidson	
Public Schools—Ballistic Attacks: Assessment and Mitigation.....	69
Yousef Alostaz and Lazar Kesic	
Safety Assessment of Cables of Suspension Bridge under Blast Load.....	79
Atta E. Mustafa, Ali Javed, and Khawaja Ali	

Bridges, Tunnels, and Other Transportation Structures

Investigation of the Rotation Capacity and Flexural Strength of Web Tapered Hybrid High Strength Steel Simple Supported I-Section	94
Chungom N. Ntonifor, Mehdi Shokouhian, and Muritala Adegoke	
AFRP Reinforced Concrete Column with Controlled Rocking Connection	113
Muritala Adegoke, Mehdi Shokouhian, and Chungom Ntonifor	
California's First Major Vehicular Cable-Stayed Bridge.....	135
Michael J. Borzok	

Innovative Methods for Evaluation of Precast Box-Beam Bridges.....	148
Mohammad Abedin, Francisco J. De Caso y Basalo, Nafiseh Kiani, Armin B. Mehrabi, and Antonio Nanni	
Machine Learning Approach to Visual Bridge Inspection with Drones	160
Junwon Seo, Euseok Jeong, and James P. Wacker	
Manulife Place Plus 15 Pedestrian Bridge Connections and Details	170
Kevin Chang, Dane Rankin, and William Baker	
Optimization and Evaluation of Pipe-Tie System in Limiting the Exterior Girder Rotation during Deck Construction	179
Li Hui, Faress Hraib, Miguel Vicente, and Riyadh Hindi	
Stainless Steel-Concrete Composite Beams Strengthened with External Tendons	189
My-Lin Van and Ayman El-Zohairy	
Steel Shark Fin Deck Anchors for Cable-Stayed Bridges: Form, Function, and Fabrication.....	202
Jason Salonga	

Buildings

Experimental Study of a Novel Self-Centering Beam-Column Connection Equipped with Shape Memory Alloy Plates	215
Michael C. H. Yam, Xuhong Zhou, Yun Huang, and Ke Ke	
Innovative CLT Gravity and Lateral Systems for Vancouver School Projects.....	225
Md. Shahnewaz, Carla Dickof, Nick Bevilacqua, and T. Tannert	
Novel Hold-Down Solutions for Cross-Laminated Timber Shear Walls.....	232
Thomas Tannert	
Resistance of Eccentrically Connected Gusset Plates in Compression	239
Jan Vesecký, Michal Jandera, and Kamila Cábová	
The Arbour: An Innovative Composite Floor System.....	251
Md. Shahnewaz, Robert Jackson, and Thomas Tannert	

Business and Professional Practice

Business Resilience as Strategy for Survival and Pandemic Recovery of Selected Engineering Construction Companies in Thailand	260
Soontorn Piromsartkoon	
Design Behavior: How to Save Our Planet and Influence People	271
Dan Bergsagel	

Education

Mixed Reality Applications for Teaching Structural Design.....	283
M. A. Kraus, I. Čustović, and W. Kaufmann	

Forensic

Alkali-Silica Reaction Induced Damage and Strength Degradation in Textile Mill	296
Ahsan R. Khokhar and Fizza Hassan	

Forensic Investigation of Fire-Induced Collapse of a Steel Building	312
Mohammadreza Eslami, Khalid M. Mosalam, Ankit Agrawal, Amarnath Kasalanati, Shalva Marjanishvili, and Venkatesh Kodur	

Investigation of Fire Incidents and Associated Damage to Buildings	330
M. Mehdi Mirzazadeh and Mark P. Milner	

Scott Candler Electrical Building Forensic Investigation and Repair	340
Donnell Duncan	

Innovative Research

Cross-Laminated Timber Concrete Composite Systems for Long-Span Floors	356
Md. Shahnewaz, Robert Jackson, and Thomas Tannert	

Failure Modes of 3D-Printed Tessellated-Tile Beams	364
Grace F. Crocker, Sida Dai, Brandon E. Ross, Michael Carlos Kleiss, Pinar Okumus, Negar Elhami-Khorasani, and Seth Moore	

Repairable Modular Structural-Architectural Shear Walls.....	377
Mohammad Syed, Grace F. Crocker, Negar Elhami-Khorasani, Pinar Okumus, Brandon E. Ross, and Michael Carlos Barrios Kleiss	

Replaceable Buckling-Restrained Brace Coupling Beams in Core Walls	387
Joseph Collins and Kion Nemati	

Ultimate Foundation Moment Capacity of Any Plan Shape under P-M-M Loading.....	398
Roy Lobo and Chris Tokas	

Natural Disasters

The Statistical History of US Tornadoes	413
William J. Kirkham	

Nonbuilding and Special Structures

An Overview of the Upcoming ASCE Report on Design of Modular Structures for Industrial Facilities426

Silky Wong

Analysis of SPMT Transport of Large Onshore Modules430

William Bounds and Bradley Tann

Nonstructural Components and Systems

Effects of Permeability on the Dynamic Properties and Weathertightness of Double Skin Curtain Walls444

Kehinde J. Alawode, Krishna Sai Vutukuru, Amal Elawady, Seung Jae Lee, Arindam Gan Chowdhury, and Guido Lori