

Lecture Notes in Civil Engineering

Wei Guo
Kai Qian
Honggang Tang
Lei Gong *Editors*

Proceedings
of the 2023
International
Conference on Green
Building, Civil
Engineering and Smart
City

 Springer

Editors:

- [Wei Guo](#),
 - [Kai Qian](#),
 - [Honggang Tang](#),
 - [Lei Gong](#)
-

- Raise awareness of the vital importance of sustainability in infrastructure
- Gathers the emerging technologies and applications in civil engineering
- Highlights latest research findings involved in any aspects of Civil Engineering
- **Part of the book series:** [Lecture Notes in Civil Engineering](#) (LNCE, volume 328)
- **Conference series link(s):** [GBCESC: International Conference on Green Building, Civil Engineering and Smart City](#)
- **4132** Accesses

About this book

The book gathers the emerging technologies and applications in various disciplines involving green building, smart infrastructure and 3D Printing, which are presented in high-quality papers of GBCESC. Moreover, by sharing knowledge and experiences around emerging civil engineering and smart city, the book aims to provide readers with an overview of the emerging trends in the fields of green building, Civil Engineering and Smart City. The topics covered include Structural Engineering, Geological Engineering, Smart Cities, Urban Planning and Design, Construction Technology, green building technology, etc. This book will be useful for researchers and professionals in designing, building, and managing sustainable buildings and infrastructure.

Editors and Affiliations

- Central South University, Changsha, China
Wei Guo
- Guilin University of Technology, Guilin, China
Kai Qian
- Guizhou University, Guiyang, China
Honggang Tang, Lei Gong

Bibliographic Information

- **Book Title** Proceedings of the 2023 International Conference on Green Building, Civil Engineering and Smart City
- **Editors** Wei Guo, Kai Qian, Honggang Tang, Lei Gong
- **Series Title** [Lecture Notes in Civil Engineering](#)
- **DOI** <https://doi.org/10.1007/978-981-99-9947-7>
- **Publisher** Springer Singapore
- **eBook Packages** [Engineering, Engineering \(R0\)](#)
- **Copyright Information** The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2024
- **Hardcover ISBN** 978-981-99-9946-0 Published: 02 February 2024
- **Softcover ISBN** 978-981-99-9949-1 Due: 16 February 2025
- **eBook ISBN** 978-981-99-9947-7 Published: 01 February 2024
- **Series ISSN** 2366-2557
- **Series E-ISSN** 2366-2565
- **Edition Number** 1
- **Number of Pages** XVIII, 1040
- **Number of Illustrations** 177 b/w illustrations, 487 illustrations in colour
- **Topics** [Civil Engineering](#), [Public Policy](#), [Arts](#)

Cite this paper

Tong, J.W.Y., Hashim, N.H.B., Lee, Y.H., Lee, Y.Y. (2024). CFD Analysis of Thermal Comfort Condition Inside Malaysian Traditional House. In: Guo, W., Qian, K., Tang, H., Gong, L. (eds) Proceedings of the 2023 International Conference on Green Building, Civil Engineering and Smart City. GBCESC 2023. Lecture Notes in Civil Engineering, vol 328. Springer, Singapore. https://doi.org/10.1007/978-981-99-9947-7_52

Download citation

- [.RIS](#)
- [.ENW](#)
- [.BIB](#)
- DOI https://doi.org/10.1007/978-981-99-9947-7_52
- Published 02 February 2024
- Publisher Name Springer, Singapore
- Print ISBN 978-981-99-9946-0
- Online ISBN 978-981-99-9947-7
- eBook Packages [Engineering Engineering \(R0\)](#)

Table of contents (99 papers)

Experimental Investigation on Shear Connectors for Glulam-UHPC Composite Structures

- Wanru Huang, Pengcheng Li, Xiaoyue Zhang

Pages 3-11

A Dynamic Detection Method for Railway Track Irregularities Combining Line-Structured Lasers and GNSS/IMU

- Tong Wang, Haoxuan Xu, Qingzhou Mao, Yuanbo Mu, Guangqi Wang

Pages 12-21

Seismic Performance of Bridge Piers with Pile Foundations Under Frozen Soil Conditions

- Wanping Wang, Xiyin Zhang, Shengsheng Yu, Jiada Guan

Pages 22-30

Application of Big Data Analysis in Bridge Monitoring System

- Xian Xiao

Pages 31-37

Design of the Stiffener Layout for Dome Structures Based on Topology Optimization

- Yougang Wang, Dingkun Chen, Yunlun Sun, Zitong Bao, Junhong Zhang, Weipeng Xu et al.

Pages 38-46

Feasibility Study of Optimization of Ultrasonic Tomography Algorithm in Concrete

- Lu Zhang, Chong Qiao, Shangda Jia, Hongyu Li

Pages 47-58

Static and Dynamic Analysis of Construction Catwalk of Long-Span Suspension Bridge

- Jinguo Jiang, Jihua Xiong, Feng Wang

Pages 59-71

Feasibility Study on Angle Integral Deformation Measurement Method of Inclination Sensor in Existing Railway Deformation Monitoring

- Yufeng Xu, Yongmao Tang, Gui Li, Fentao Guo, Zhuobin Huang

Pages 72-82

[Seismic Response of Bridge Pile Foundation in Permafrost Incorporating Advanced Pile-Soil Dynamic Interaction Model](#)

- Shengsheng Yu, Xiyin Zhang, Wanping Wang, Jiada Guan

Pages 83-91

[Study on the Calculation of Bending Capacity Based on UHPC Design Codes](#)

- Lei Sun, Jianluan Li

Pages 92-97

[Choice of Soil Constitutive Models in Numerical Analysis of Foundation Pit Excavation Based on FLAC3D](#)

- Shang Xiao, Ming Xu, Riyan Lan

Pages 98-110

[Application of Endurance Time Method in the Seismic Responses Analysis of Free-Field Site](#)

- Wenting Li, Haozhe Xu

Pages 111-116

[Compressive Stress-Strain Relationships of Wall Sheathings Used in Cold-Formed Thin-Walled Steel Shear Walls](#)

- Song Hu, Li Zhou, Yong Huang, Chao Yin, Qingyu Zou, Yifeng Xu

Pages 117-127

[Research on Impact-Abrasion Resistance of High-Strength Concrete with Recycled Rubber](#)

- Yuancong Liu, Jiangfeng Dong, Yi Xu, Qingyuan Wang, Dekun Peng

Pages 128-135

[Structural Force Analysis and Service Condition Monitoring of a Port Door Machine](#)

- Wei Sun, YaYa Gao, PeiXuan Yan

Pages 136-144

A Novel Self-Recovery Tri-stable Damper: Design and Analysis of the Energy Dissipation Performance

-
- Hongyu Li, Xiangxing Zeng, Liling Xie, Lu Zhang
-

Pages 145-155

Effect on Autogenous Volume Deformation of Concrete Mixed with Magnesium Oxide and Polyethylene Fiber

-
- Shaolian Yan, Weiwei Li, Tijiang Fu, Ziyu Song, Xue Luo, Guigang Jin
-

Pages 156-166

Research on Critical Technology of Cable Hoisting Construction of Large-Span Bridge

-
- Jihua Xiong, Jinguo Jiang, Xu Liu, Pengcheng Li

Pages 167-183

Numerical Simulation Analysis of the Influence of Recharging Wells on the Settlement of Buildings Surrounding Deep Foundation Pits

-
- Caihaiduojie, Haifeng Tian, Xugang Yin
-

Pages 184-195

Meso-Scale Study on Dynamic Shear Property and Size Effect of RC Beams Reinforced with CFRP

-
- Dong Li, Bo Yang, Jiangxing Zhang, Liu Jin, Xiuli Du
-

Pages 196-203

Experimental Investigation on the Interfacial Bond Failure Between FRP Bars and Sea Sand Concrete

-
- Ben Yang, Chunheng Zhou, Zihua Zhang
-

Pages 204-213

On the Finite Element Modelling of Long-Term Behavior of Pre-cracked RC Beams Strengthened with FRP

-
- Weilai Yao, Tao Sun, Yuanxue Liu, Junru Ren, Rui Mu, Xinlei Cheng et al.
-

Pages 214-225

Simulation Analysis of Reflection Crack Propagation Path of Asphalt Overlay Under Coupling Load

- Qinshou Huang

Pages 226-234

Environmental Disturbance Analysis and Control in the Excavation of a Foundation Pit Near a Building Structure

- Xitao Lin, Fan Mo, Yuebang Cui, Jinli Xie, Gui Huang, Hailin Cheng et al.

Pages 235-243

Topology Optimization Design of Liquid-Cooled Radiator Based on Variable Density Method

- Kaixun Jia, Bin Zhang

Pages 244-250

Simulation Analysis of Long-Span Single-Tower Hybrid Beam Cable-Stayed Bridge

- Tonghui Jiang, Jiading Yang, Dequan Zhu, Yufeng Xu, Mengyang Zhu

Pages 251-258

The Influence of Multi-level Loading on Cracking Behavior of Sandstone with a Single Flaw

- Yuxin Li, Pengzhi Pan, Shuting Miao, Yujie Feng

Pages 259-266

Study on Seismic Damage Mode and Key Construction Damage Mechanism of Highway Pile-Plate Structure

- Xiaoming Liu, Feng Xue

Pages 267-273

Free Vibration and Tension-Bending Coupling Behaviors of Sandwich Panels with Novel Tri-Chi Honeycomb

- Minfang Chen, Yifeng Zhong, Irakoze Alain Evrard, Xiaoquan Liu

Pages 274-281

Research on Construction Scheme for a Four-Span Continuous Slanting Heterotypic Stay Cable Arch Bridge

- Yufeng Xu, Zihui Li, Zhantao Zhang

Pages 282-291

Study on Seismic Reduction Effect of Friction Pendulum Isolation Bearing in Curved Beam Bridge with Variable Height Pier

- Jiada Guan, Xiyin Zhang, Xingchong Chen, Yongliang Zhang

Pages 292-299

Experimental Study on Direct Tensile Properties of UHPC

- Huiqing Xue

Pages 300-306

Attitude Adjustment Technology of Rectangular Pipe Jacking

- Jiangsheng Xie, Hongbin Guo

Pages 307-313

Numerical Study on Performance of Single-Keyed Epoxy Joint of Ultra-high Performance Concrete (UHPC) Under Combined Shear and Torsion Load

- Zhe Li, Yun Shen, Lei Sun

Pages 314-321

Simulation Analysis of the Construction Process of a Hybrid Girder Cable-Stayed Bridge with Profiled Towers

- Tonghui Jiang, Jiading Yang, Dequan Zhu, Yufeng Xu

Pages 322-333

Calculation and Analysis of Embodied Carbon Emissions in Open Cut Foundation Pits

- Lianjin Tao, Kaiyue Sun, Xu Zhao

Pages 334-348

A Design Method Based on 3D Printing for the Integration of Human Computer Dynamic Interaction and Digital Sculpture

- Zhen Zheng

Pages 349-356

Study on the Mix Proportion of Waste Marble Powder-Ground Granulated Furnace Slag-Based Alkali-Activated Ultra-high Ductility Concrete

- Yi Zhang, Ruihao Ren, Binyu Mo, Rongcun Mu, Ting Huang, Bing Liu
Pages 357-368

Effect of Waterborne Epoxy Resin on the Shrinkage and Mechanical Properties of Geopolymer Material

- Huachong Cai, Hanqing Liu, Xiongfei Liu, Yaoyao Wu

Pages 369-375

Preparation and Performance Study of Slag-Waste Marble Powder Based Alkali-Activated High Performance Concrete

- Xiaofang Deng, Weixin Lin, Hongtao Li, Yuanju Li, Yunhao Weng, Bing Liu

Pages 376-386

Effect of Sintering Temperature on Properties of Regenerated Sintered Sheet Brick

- Bing-zhang Huang, Guang-feng Li, Li-hua Pan, Yu Zhang, Bang-biao Huang

Pages 387-396

Research on Crack Control Method of Girder End Anchorage Zone Based on Nonlinear Finite Element Analysis

- Tongyi Wang, Jinjian Gu, Jianrong Xu

Pages 397-404

Optimization of Optimal Pre Maintenance Timing Decision for Asphalt Pavement Based on Matter Element Analysis and Combination Weighting

- Ying Li, Qiangnian Li

Pages 405-413

Research on Reinforcement Cage Connection Techniques for Cast-in-Place Concrete Piles

- Haijun Wang, Weiqiang Chen, Hongjun Lv, Wenxian Yang, Minting Zhong

Pages 414-420

Study on Hole Cleaning Construction Technology of Bored Cast-in-Place Pile

- Xuefeng Shi, Weiqiang Chen, Hongyan Sun, Shuqiang Cao, Peng Sun, Xingpei Wu
-

Pages 421-429

[Design and Experimental Study on a Novel Direct Measuring Force Device for Rod-Cable Structure Bridge Cables](#)

-
- Jinggan Shao, Tingdong Shang, Genshang Wu, Wei Liu, Le Bo, Xuling Liu

Pages 430-438

[Effect of Embedded Filament Fibers on Mechanical Properties of 3D Printing Cement-Based Materials](#)

-
- Weihong Li, Xuhao Chen, Yaoyu Wang, Detian Wan, Nan Li, Fenghai Ma

Pages 439-446

[Frictional Rotation Performance Study Based on Non-Standard Bolt Hole Nodes](#)

-
- Qikai Liu, Yueguo Zhang, Xuyu Cheng

Pages 447-457

[Fragility Analysis of Pier-Tower-Girder Fixed Cable-Stayed Bridge Subjected to Near-Fault and Far-Fault Ground Motions](#)

-
- Wei Xia, Qiliang Si, Nailiang Xiang

Pages 458-469

[A Brief Review on Compression Strength Prediction Models of Alkaline-Activated Slag Concrete](#)

-
- Yeong Huei Lee, Yee Yong Lee, Siaw Fui Kiew, Yie Hua Tan, Cher Siang Tan

Pages 470-485

Green Building

Front Matter

Pages 487-487

[PDF](#)

[Energy Performance Optimisation of Low-Rise Lightweight Steel-Frame Houses by Evolutionary Approach](#)

-
- Yang Yang, Marco Cimillo, Xi Chen

Pages 489-497

CFD Analysis of Thermal Comfort Condition Inside Malaysian Traditional House

- Joristine Wong Yun Tong, Nur Hasyimah Binti Hashim, Yeong Huei Lee, Yee Yong Lee

Pages 498-510

Numerical Analysis of Improvement Effects on Summer Outdoor Thermal Environment Around Enclosed Teaching Buildings in the Hot-Humid and Less-Windy Climate

- Xuexiu Zhao, Yigang Li

Pages 511-519

Accounting for Carbon Emissions During the Building Phase of Academic Buildings

- Jie Gao, Shenqi Gan

Pages 520-528

Research on Measurement and Optimization of an Old Building in Wuxi Based on Ultra-low-energy Consumption and Energy Saving Transformation

- Wei Zhang, Jie Wu, Jinghua Shen, Zhijun Xue

Pages 529-539

Development Research on Openness Evaluation Factors for Pocket Parks

- Yunjie Sun

Pages 540-550

Study on Landscape Characteristics and Formation Mechanism of Chinese Traditional Settlements Based on Niche Theory

- Jianfu Chen, An Yan, Hailing Sun

Pages 551-559

Towards a Sustainable Future: Timber Waste Management in New Zealand's Construction Industry

- Dat Tien Doan, Ping Sun

Pages 560-569

Quantitative Study on the Evolution of Urban Residential Spaces from the Perspective of Regionalism: A Case Study of Shanghai Lane Houses

- Yaru Xu
-

Pages 570-579

Thermal Process Analysis in Passive Solar Dormitories in Plateau Areas: Onsite Case Study in Zoige

-
- Diqing Wang, Jifan Cao, Yin Zhang, Dongsheng Huang
-

Pages 580-590

Functional Floor Plan Adaptation for Age-Friendly Housing in the Context of Ageing in Place

-
- Feng Wang, Bo Zhang, Xiangyun Wang, Jie Liu
-

Pages 591-597

Identifying Architectural Forms and Evaluating the Climate Adaptability of Traditional Buildings in Southwest China

-
- Chenpeng Xu, Keding Lu
-

Pages 598-606

Research on the Characteristics and Influencing Factors of Spatial Soundscape Perception in University Campuses: Guizhou University as an Example

-
- Yonghe Ma, Honggang Tang, Xiaoheng Zhou
-

Pages 607-620

Numerical Simulation of Indoor Air Quality and Aerosol Diffusion in Gym

-
- Zhiqiang Kang, Baorui Hao, Ning Yin, Tong Wang
-

Pages 621-628

Ecological Construction Strategy of Traditional Houses in Qianzhong Tunpu: A Case Study of Yunshan Tun

-
- Fang Han, Jian Yue, Zhuo Chen, Jian Liu
-

Pages 629-637

Research on Forward Design of Green Office Building Based on BIM

-
- Hui Cao, Ruixin Ju, Zhibo Wang, Dan Fu
-

Pages 638-651

Research on the Comfort of Outdoor Thermal Environment in Old Communities in Mild Climate Areas

-
- Yiming Xing, Yan Wang

Pages 652-664

Research on Reformation of Illuminance Uniformity in University Ladder Classroom

-
- Saitong Li, Yan Wang, Qihua Kuang, Qiang Wu

Pages 665-676

Analysis and Study on Climate Adaptability of Traditional Houses in Jianghuai Region of Anhui Province, China

-
- Ziteng Han, Shan Wu, Wei Wang

Pages 677-686

Thermal-Economic Performance Evaluation of Air Conditioning for Office Buildings

-
- Jifan Cao, Diqing Wang, Hongli Sun, Yin Zhang

Pages 687-695

Research on Green Construction Technology of Traditional Buildings in Northern Anhui Based on Climate Adaptability

-
- Manting Zhu, Anqi Liu, Wei Wang

Pages 696-702

Simulation of Different Ventilation Methods on Indoor Air Quality and Thermal Comfort in College Classroom

-
- Zhiqiang Kang, Ning Yin, Baorui Hao, Yunyi Wang

Pages 703-710

A Study on the Scenic Beauty of Huangguoshu Scenic Area Based on SD and SBE Method

-
- Xinren Zhang, Zongsheng Huang

Pages 711-729

A Study on the Characteristics and Optimization of the Soundscape of the Miao Settlement in Southeast Guizhou: A Case Study of the Thousand Miao Villages Xijiang

- Qihua Kuang, Rui Yang, Yan Wang, Xiaomei Li, Qiang Wu, Saitong Li

Pages 730-744

[Wayfinding Oriented Evidence-Based Design for Building Optimization](#)

- Qian Cao, Jingyi Li, Shuyang Li, Moxuan Shen, Weiyi Liang, Kaiyu Lu

Pages 745-755

Smart City

Front Matter

Pages 757-757

[PDF](#)

[Efficient Prediction of Indoor Airflow in Naturally Ventilated Residential Buildings Using a CFD-DNN Model Approach](#)

- Tran Van Quang, Nguyen Lu Phuong, Dat Tien Doan

Pages 759-770

[A Genetic Algorithm Using Diversity-Concern Principle to Solve Robust Influence Maximization Problem on Urban Transportation Networks](#)

- Minghao Chen, Shuai Wang

Pages 771-781

[The Feasibility Study of the Rapid Damage Inspection Technique in Municipal Pole Structure Using UAV](#)

- Lu Zhang, Yating Liu, Hongyu Li

Pages 782-789

[Identifying Key Nodes in Urban Transportation Systems Using the Information Diffusion Model](#)

- Yongbin He, Siheng Ren, Shihan Chen, Shuai Wang

Pages 790-800

[Research on Lighting Evacuation Method Based on Visual Attention Mechanism Analysis](#)

- Ce Zheng, Mingyu Zhang, Yu Chang

Pages 801-812

ANN-Based High-Dimensional Multi-objective Optimal Design for Natural Lighting in Large-Span Buildings

-
- Jinlong Zou, Lei Feng, Zhongrong Liu

Pages 813-826

Research on Intelligent Monitoring System of Urban Network Database

-
- Xusheng Tang, Jie Liu

Pages 827-834

Data Mining and Retrofit Design for Age-friendly Spaces

-
- Jie Liu

Pages 835-843

The Ecological Wisdom of Water Management in Traditional Villages in Northeast China, Hubei Province

-
- Lilan Luo, Changyou Wu, Hui Feng, Haiyu Xia

Pages 844-850

An EV Charging Station Siting Model Based on Machine Learning

-
- Yufang Dai, Minghao Liu, Xiangli Liao

Pages 851-860

Research on Influencing Factors of Smart City Construction Capability Based on DEMATEL-ISM

-
- Xiaoheng Zhou, Honggang Tang, Wenyao Xiao

Pages 861-874

-
2. ***Research on the Renewal Design of Community Public Space Under the Smart Elderly Care Model***

- Lang Lyu, Honggang Tang, Biao Wang

Pages 875-891

Research on the Regional Adaptability Strategies of Elderly Activity Facilities in Temperate Area

-
- Honggang Tang, Dongyan Jiang

Pages 892-902

Constructing a Framework for Measuring TOD Community Scenarios Based on Big Data Analysis

-
- Suli Chen, Yun Xiong

Pages 903-915

A Computational Analysis Method to Evaluating Experiential Qualities of Historical Streets in Sustainable Townscapes

-
- Yabing Xu, Hui Tong, Wenpeng Song, Zhao Li, John Rollo, Pengfei Zhao et al.

Pages 916-925

Research on the Construction System of Traditional Wooden Dwellings of Miao Nationality in Southeast Guizhou Based on BIM Technology

-
- Shuang Liu, Lei Gong, Li Zhou, Chengyang Liu

Pages 926-936

Analysis of the Impact Mechanism of Smart City Construction on Low Carbon Development Based on Multi Phase DID Evaluation

-
- Wenyao Xiao, Honggang Tang, Lang Lyu

Pages 937-948

Influence Factors Analysis of Aging Landscape Based on the Characteristics of the Elderly Human Body

-
- Xiangyun Wang, Alamah Misni, Feng Wang

Pages 949-959

Research on the Causes and Treatment Methods of Urban Flood Points

-
- Sicheng Wang, Ruili Chang

Pages 960-971

Identification the Causes of Negative Emotions in Smart Public Transportation Services Based on Social Media Data

- Yanfang Shou, Jianmin Xu

Pages 972-981

Research on Sponge Transformation and Renewal Design of Old Residential Districts in Mountain Cities from the Perspective of Resilience

- Peijun Feng, Jiatao Fan, Sicheng Wang

Pages 982-1003

Study on "Intelligent" Renewal Strategy of Block Under Stock Optimization

- Yao Wu, Tianhui Li, António Candeias

Pages 1004-1012

Evaluation of Urban Habitat Quality Based on Theory of Humanistic - A Case Study of HeFei Metropolitan Circle of China

- Xingang Yang, Mengyuan Jin, Xueyan Liu

Pages 1013-1029

An Examination of the Suzhou Folk House Patio Space's Regional Characteristics Under the Concept of the Smart City

- Tianhui Li, Yao Wu

Pages 1030-1036

Back Matter

Pages 1037-1040

CFD Analysis of Thermal Comfort Condition Inside Malaysian Traditional House

- [Joristine Wong Yun Tong](#), [Nur Hasyimah Binti Hashim](#), [Yeong Huei Lee](#) & [Yee Yong Lee](#)
- Conference paper [First Online: 02 February 2024](#)
- **44** Accesses
Part of the [Lecture Notes in Civil Engineering](#) book series (LNCE, volume 328)

Abstract

It is crucial to ensure safe, healthy and comfortable indoor air conditions in buildings. Indoor thermal comfort is an essential aspect of sustainable architecture and is also the key to maintaining a safe indoor environment. The use of natural ventilation has been increasingly recognised as an energy-efficient method to establish thermal comfort. This study is to analyse the thermal comfort condition inside the traditional house using Computational Fluid Dynamics (CFD) software, ANSYS FLUENT and to compare the results with the thermal comfort recommended by ASHRAE standards. Previous studies of thermal comfort in hot and humid climate countries like Malaysia. The developed CFD model was validated by comparing experimental and simulated data. The experimental data are compared with the simulation results, which are in good agreement. From the results obtained, the confidence level is up to 99%. A series of simulations are also conducted to determine the air temperature and air velocity distribution inside the traditional house. The results show that the indoor air temperature of a traditional house is between 27.35°C and 27.60°C, and the air velocity is between 0.20 m/s and 0.68 m/s which are all within the thermal comfort range of ASHRAE standard. The obtained results indicate that the traditional Malay house's design effectively provides natural ventilation for thermal comfort. In addition, the research result will provide a reference for the modern architect to design houses with local architectural design characteristics.

Keywords

- [thermal environment](#), [thermal comfort](#), [traditional Malay house](#), [natural ventilation](#)

Authors and Affiliations

1. **Department of Civil and Construction Engineering, Faculty of Engineering and Science, Curtin University Malaysia, CDT 250, 98009, Miri, Sarawak, Malaysia**
Joristine Wong Yun Tong, Nur Hasyimah Binti Hashim & Yeong Huei Lee
2. **Department of Civil Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, 94300, Kota Samarahan, Sarawak, Malaysia**
Yee Yong Lee
Corresponding author
Correspondence to [Yeong Huei Lee](#).