

# GSCAEE-2021

Global Summit on Civil, Architectural and Environmental Engineering

**July 19-21, 2021 Barcelona, Spain**



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Global Summit on Civil, Architectural and Environmental Engineering  
July 19-21, 2021 | Barcelona, Spain

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## FOREWORD

Dear Colleagues,

As the Chairperson of the Conference Committee, I am honored to greet and welcome all of you to the Global Summit on Civil, Architectural and Environmental Engineering-2021. We are opening the conference in the charming city of Barcelona, and we hope that our conference here will be held with great success.

The program committee did its utmost to prepare a serious and rich program. An important defining characteristic of our conference is it is multidisciplinary, as it includes engineers from various fields. All of this provides a unique platform for communication and cooperation with colleagues from various professions, traditional schools and regions of the world.

We are confident that over the two days you will get theoretical grounding, practical knowledge, and personal contacts that will help you build long-term, profitable and sustainable communications among researchers and practitioners in a wide variety of scientific areas with a common interest in Civil, Architectural and Environmental Engineering.

I would like to sincerely thank our international team who are responsible for the preparation of the conference, and who devoted a lot of their time to make this conference a success. And finally, I would like to thank all of you, dear participants for bringing your ideas, knowledge and expertise to this interesting sphere with the noble goal of making the world better for future generations. I wish all of you new interesting contacts, fruitful work and promising joint initiatives!

Hope you enjoy the conference, the hospitality, and the beautiful and charming environment of Barcelona!

Welcome to GSCAEE2021 Spain Conference!

Best Regards,  
Prof. Venkatesh Kodur  
Chairperson of the Conference Committee,  
Michigan State University, USA

## COMMITTEES

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# **Keynote Forum** **Day-1**

**Patrizia Piro<sup>\*2</sup>**

Behrouz Pirouz<sup>1</sup>, Stefania Anna Palermo<sup>2</sup>, Michele Turco<sup>2</sup>, and Patrizia Piro<sup>\*2</sup>

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## The Role of Atmospheric Water Harvesting Systems in Green Roofs and Walls

### Abstract

The advantages of green roofs and walls are plenty, such as flood management, decreasing energy consumption, improving air and water quality, and reducing noise pollution. However, the water requirements during the summer should be taken into consideration. Moreover, the potential of atmospheric water harvesting is enormous in different climates but using atmospheric water harvesting for irrigation of green roofs and walls received less attention in the previous studies. In this regard, the advantages of atmospheric water harvesting for water requirements of green roofs and walls are investigated in this paper. Three different climates have been selected for the analysis, and the efficiency of combined systems has been investigated. The results present the fog/dew harvesting limits and potential for irrigation of the green facilities as two non-conventional water resources. According to the analysis, the multipurpose green roof and walls combined with atmospheric water harvesting have several benefits and could be less dependent on the urban water resources. In addition, with enough irrigation in the summer, the thermal efficiency of the green roofs and walls could increase and, as a result, less water footprint in the power plants for producing electricity.

### Keywords

*Green Roofs; Green walls; Atmospheric water harvesting; Sustainability*



# **Invited Forum** **Day-1**

**C. Yang<sup>1\*</sup>**

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## Improving the Seismic Resilience of Precast Concrete Bridges

### Abstract

Precast concrete elements are under-utilized in seismic regions. This research investigated methods for lowering seismic damage to precast concrete piers to deploy accelerated construction in seismic regions. Limitations of existing precast pier systems were addressed by utilizing alternative materials and rocking systems. A novel precast pier system was developed.

Unlike precast concrete systems that emulate cast in place construction, non-emulative precast concrete systems are not expected to behave like cast-in-place concrete. They can achieve self-centering and overall damage control through developing rocking. Seismic damage in these systems is primarily in two forms: concentrated concrete spalling and post-tension loss. To minimize the damage, Ultra-High Performance Concrete (UHPC) with and without mild-reinforcement is used in damage-prone regions of rocking precast piers. Large-scale test results demonstrated that UHPC is able to control seismic damage near the rocking plane, even without any mild-reinforcement.

A new hybrid, post-tensioned precast segmental pier was developed to combine emulative and non-emulative behavior to balance energy dissipation and self-centering. A design procedure based on a computationally efficient analytical model was developed to select design parameters and to accommodate UHPC. Material properties of UHPC were selected through material scale testing of commercially available UHPC products. A set of large-scale quasi-static test results showed that this system can strike a balance between self-centering and energy dissipation, and that damage due to bending can be alleviated when UHPC replaces conventional concrete.

### Keywords

Accelerated Bridge Construction, Precast Concrete, Seismic Damage Mitigation, Earthquake Resilience, Ultra-high Performance Concrete.

**O. Salem<sup>1</sup>**

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## **BIM for FM: A Life Cycle Approach for Building and Infrastructure Asset Management**

### **Abstract**

Building information modeling (BIM), an integrated data exchange and management platform, is becoming increasingly popular worldwide for the design and construction phases for projects in the built environment. Meanwhile, the adoption of BIM in the operation and maintenance (O&M) phase can be even more beneficial considering that O&M accounts for a significant portion of the life cycle costs of buildings and infrastructure elements (Hosseini et al., 2018); however, the requirements and practices of a BIM for facility management (BIM-FM) managerial framework have not been completely defined. Through extensive literature review, this study focuses on identifying the major gaps and challenges in instituting a BIM-FM system that ensures the essential project information is collected, transferred, and maintained to support O&M activities, while investigating the potential of adopting BIM-FM systems on multiple hierarchies (asset level, building level, and district/municipality level) to enable smart building operations and smart/sustainable cities and communities. It is concluded that principal requirements for a modern, automated BIM-FM system include data interoperability, scalability, cyber-security, and existing BIM tools can be integrated to fundamentally meet these requirements. Future studies may develop a usable managerial BIM-FM framework, testify its effectiveness in professional practices, and measure its contribution to quality of life in the built environment.

### **Keywords**

Building Information Modeling, Facility Management, Infrastructure Asset Management, Interoperability, Scalability, Security.

### **References**

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### **Biography**

Ossama "Sam" Salem is the chair of Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering at George Mason University. Sam has nearly 30 years of professional and academic experience at Syracuse University, University of Cincinnati, North Dakota State University, Golder Associates, and Alberta Ministry of Infrastructure. His research interests include accelerated construction of infrastructure, lean and green construction, project management, public-private partnerships, smart infrastructure, sustainable development, life cycle analysis, and infrastructure asset management. He is a registered professional engineer, certified professional constructor, and LEED accredited professional.



**A.L. Grindlay<sup>1\*</sup>**

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## **New Rail-Based Public Transport Systems and their Urban Impacts in Andalusia (Spain)**

### **Abstract**

Taking into account the close relationship between public transport systems and urban systems, this paper explores the urban interactions resulting from the new rail-based public transport systems developed in the autonomous region of Andalusia, southern Spain, where there has been a political continuity over the last three decades.

Firstly, the role of new mass public transport systems is shown as a catalyst for urban development and renewal, and as a promoter of sustainable urban mobility. In particular, the focus of this contribution is on the wider interactions of the rail-based transport systems with urban areas and with urban mobility.

The most important action of the public transport policies in Andalusia aimed at changing its unsustainable mobility model, with its high predominance of private motorized transport modes, has been the development of a series of new rail-based public transport systems in its main metropolitan areas of Seville, Malaga, Granada, Jaen and the Bay of Cadiz. This diversity of cases and rail typologies will allow a comparative analysis, evaluating not only the improvements for their public transport systems (favouring intermodal connectivity, providing high-quality services, etc.), but also in the interactions with the urban areas and the promotion of a sustainable mobility. Some of these systems have been constructed over abandoned transit networks which disappeared during the 1960s and '70s. They are also the most relevant proposals of the existing Sustainable Urban and Metropolitan Mobility Plans; however, these have not been fully implemented. The cases studied show that their relative urban impact varies substantially depending on their diverse configurations such as surface or underground sections, urban complementary measures, etc.

The paper concludes with the limited urban interactions along their corridors and considers the missed opportunities for wider urban transformations and for integrating transportation and land use policies with strategic congruence.

### **Keywords**

rail-based public transport systems, urban impact, Andalusia

**E.K. Trifanova<sup>1</sup>**

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## Medical Geographical Analysis of Territories: Forward Leading Thinking of Digital Predictive Biogeographical Mapping of Invasive Flora

### Abstract

In this paper, authors analyze and summarize the results of various approaches to the use of methods of digital predictive biogeographic mapping in the study of invasive flora and consider the prospects for their use for the purposes of medical geographical analysis of the territory [1].

Prospects for the use of digital methods of predictive biogeographic mapping [2] have been determined by the possibility of identifying integral indicators of the relationships between a wide range of climatic, biological, meteorological data and environmental characteristics, which, in the future, can form the basis for a predictive model that estimates the spatial and temporal factor of the influence of the propagation of certain plant species on the dynamics of seasonal human disease rate.

The mapping of integral indicators of public health and environmental factors onto a digital predictive biogeographic map provides additional information about spatial differences in public health due to geographical distribution and reveals a number of regularities in the spread of seasonal diseases. Thus, the process of integrating the methods of predictive biogeographical mapping, medicine and geoinformatics enables creation of electronic predictive maps on the distribution of invasive flora, including a taxonomic database of taxon[3] with homogeneous and integral indicators.

### Keywords

invasive flora, predictive biogeography, medical geographical analysis, GIS, Remote Sensing

### Reference

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## Investigation on the Short Term Implications of a Bunker Levy for Shipping

### Abstract

The pressure for the Maritime Industry to reduce its contribution to climate change is increasing. According to the 4th GHG Study, CO<sub>2</sub> emissions grew by 9.3% from 962 million tonnes in 2012 to 1056 million tonnes in 2018. In April 2018, the Initial IMO Strategy was adopted [1], aiming to reduce the total annual GHGs from shipping by at least 50% by 2050 compared with 2008 levels, while pursuing efforts towards phasing them out entirely. However, more recently at MEPC75 (2020), the IMO has been accused to lack ambition and urgency as the latest developments on the field of short-term measures are claimed to be insufficient in achieving significant emissions reductions. According to the Strategy the list of proposed candidate measures, contain the enforcement of short, medium and long-term measures that will guarantee emissions from Shipping to decline. Medium term measures include the potential enforcement of a Market Based Measure, an environmental policy meant to internalize the external cost of emissions and provide monetary incentives to stakeholders to switch towards less polluting behaviors. This paper investigates the short-term impacts of the implementation of an environmental tax such as a bunker levy on Shipping. Considering that a tax will increase the operating costs of the ship, the paper makes an empirical study on the effects of bunker prices and freight rates for major shipping routes from 2010 until 2018 and compares them with the evolution of speed based on the data of the 4th GHG study [2]. Finally, the paper introduces a modelling approach that can estimate the optimal laden and ballast speed after the implementation of a tax and concludes with an estimation of the final annual amount of CO<sub>2</sub> emissions after tax for a tanker case study.

### Keywords

Marker-Based Measures, Bunker Levy, Shipping, Maritime, IMO, Greenhouse gas

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## Impact of Climate Change on Water Management in Banat Field, Romania

### Abstract

Climate change is an undisputed fact, researched, analysed and recognized by all decision-makers, with the Intergovernmental Panel on Climate Change (IPCC) stating that "Scientific evidence for warming of the climate system is unequivocal", with most climate change being exacerbated since 1950, after the industrial revolution [1]. Numerous studies have been conducted to observe Climate Change and how we can prevent negative effects, all adapted to a region scale [2,3,4,5]. Generally, climate change on the water circuit in nature is manifested by changes in rainfall distribution, causing severe flooding in some areas at the same time as drought-affected areas in other regions [6,7,8,9]. Climate change in Romania and the Banat Plain, analysed over a period of 122 years (1898-2020) comply with global trends, being characterized by precipitation with high intensities in the spring causing floods and an increase in aridity during the summer, causing drought [10].

This paper examines how changes in the distribution of rainfall given by climate change led to changes in the flow of water into the Timis river, an analysis extended which runs from 2015 to 2020. Unevenly distributed rainfall has resulted in the flow rate and maximum level (566.0 mc/s, 302 cm in May) and paradoxically the flow rate and the minimum level (27.5 mc/s, 7 cm in September) in the period considered (2019) and the maximum level (566.0 mc/s, 302 cm in May) as well as paradoxically the flow and the minimum level (27.5 mc/s, 7 cm in September), the annual flow being also an average value. The year 2020 was an exceptional year, the heavy rainfall of 16, 17 and 18 June 2020 of 150 - 170 litres /sqm, led to the formation of a historical flash flood on the Timis river and the Bistra and Poganis tributaries, near Lugoj, at a level that has not been recorded for 200 years, the previous historical flood being in 2005. In these circumstances, measures must be taken to adapt to climate change, from monitoring the leakage of water by advanced methods of scanning [11,12] to flood protection strategies such as: dams cant works, river development and flow regulation works, interception of flood waves in permanent and non-permanent accumulations, as well as derivation or blocking of flood waves by the double connection Timis-Bega.

Water management under climate change should consider reducing the negative impact on population health, economic situation, environment, and cultural heritage by adopting procedures, policies, and practices at regional, basin and located areas with potentially significant flood risk. Proper and efficient water management for the proper functioning of the complex hydrological system is both hydrotechnical works to protect against floods and the measures that are taken before, during and after a flood. At European and global level, the EU Water Framework Directive (WFD) includes mechanisms to adapt water management to climate change [13,14,15], while highlighting the need to harmonise efforts at European and global level to ensure the capacity of water management

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objectives and to steer towards sustainable water management [16].

### Keywords

climate change, water flow, level of water, floods, drought, water management

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### Biography

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## Long-Term Durability and Mechanical Performance of Alkali-Activated Slag Cements

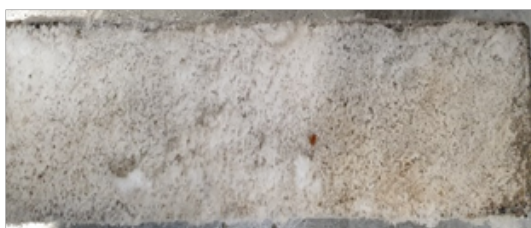
### Abstract

Alkali activated (AA) cements are considered less harmful to the environment than Portland cements (PC), as they consist of a silicate waste in lieu of a PC clinker, and this implies lower green-house gas emissions and no exhaustion of unrenewable material sources. This paper investigates cements made with ground granulated blast furnace slag (GGBS) activated with sodium hydroxide (NaOH) and sodium silicate ( $\text{Na}_2\text{SiO}_3$ ), both combined and separately, and cured at 20 and 60°C. The 28-day and 270-day strengths are compared. Furthermore, the materials are subject to accelerated weathering tests (wet-dry, salt crystallization and freeze-thaw cycles), and the strength loss, mass loss and macroscopic changes after cycling studied.

The GGBS is characterized using analytical techniques. Previous work concluded that it complies with standard requirements for the use of slags in concretes and mortars (Alelweet and Pavia 2019). The results indicate that the strength tends to increase between 28 and 270 days. The strength increase at late ages does not conform with former authors such as Collins and Sanjayan (2001) who found strength reductions at late ages due to microcrack networks that appear at late age.

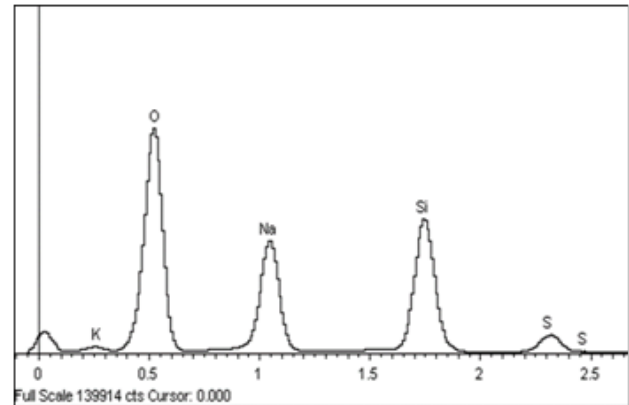
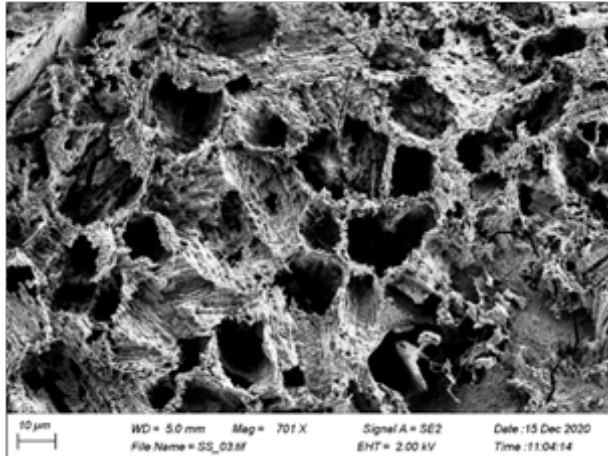
Increasing the curing temperature enhances mechanical strength at 28 days when the activator is  $\text{Na}_2\text{SiO}_3 + \text{NaOH}$  agreeing with Fernández-Jiménez et al.1999. In contrast, at late ages (270 days) despite occasional contradictions, increasing the curing temperature does not generally enhance mechanical strength also agreeing with former literature.

The strength loss due to artificial ageing is highly inconsistent as some of the weathered specimens show greater strength than the unweathered (control) ones. However, the  $\text{Na}_2\text{SiO}_3/\text{NaOH}$  activated GGBS materials clearly show the greatest resilience to the effects of frost, thermal/moisture cycles and salt action as they remained intact after cycling, while both the NaOH and the  $\text{Na}_2\text{SiO}_3$  activated GGBS materials developed slight decay including efflorescence, swelling and cracks.



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Efflorescence on NaOH activated GGBS after 20 freeze- thaw cycles (left 20°C-cured; right 60°C).



The scanning electron microscope (SEM) and EDX analyses indicate that the salts are alkali sulphates.



The microstructural (SEM) study of the best performers ( $\text{Na}_2\text{SiO}_3 + \text{NaOH}$  activated, GGBS materials) revealed areas of unreacted GGBS particles bound with scattered silica cements alternating with abundant alumino-silicates. The SEM image (left) shows the isometric and tabular alumino-silicates in the  $\text{Na}_2\text{SiO}_3 + \text{NaOH}$  activated GGBS materials.

### Keywords

GGBS, alkali activation, freeze-thaw, salt crystallization, wet-dry cycles, 270-day strength.

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## Green Public Market for Community Support and Urban Renovation

### Abstract

Urban renovation is a shared crucial issue in cities worldwide as urban “holes” and reconstruction demands are diffused and for a long time neglected, creating areas of social unrest and building decay. Europe is now engaged in a new growth strategy aimed at shifting into a modern, resource-efficient and competitive economy, where a) there are no net emissions of greenhouse gases by 2050, b) economic growth is decoupled from resource use, c) no person and no place is left behind. These targets are shall be pursued by the European Green Deal, that promotes sustainable economy by converting climate and ecological challenges into opportunities, and creating a transition primarily inclusive for all. The strong social and community engagement is tightly related to public space and buildings and the public market is vocational for the creation of a multifunctional and multi-user attraction pole: “The artist's dream, however, is to get to the museum, while the designer's dream is to get to the local markets” (Bruno Munari, 1971). The paper uses two public markets in Italy to demonstrate a new approach to this core community asset considering its features according to functions, flexibility, urban relationships and service continuity, including a low energy impact in the life cycle. The nZEB (nearly Zero Energy Building) approach is endorsed linked with a solid concept of architecture for urban renovation and social inclusion to thrive the core “stitching” role of these buildings into the cities. Appropriate technological methods and prefabrication strategies are proposed for a temporary relocation of the pavilions which are aggregated in a modular configuration for a scalable and replicable solution. The energy saving of the proposed exemplary projects is pursued in the life cycle, from the construction phase, the O&M (operational and maintenance) phase and in the end of life. The market is geared towards energy and environmental sustainability by using materials with low embodied energy and high-efficiency systems achieving a zero-carbon results by green roofing and public gardens.

### Keywords

zero-carbon architecture, public market, social inclusion, community development

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### Biography

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Department of Civil, Environmental, Architectural Engineering and Mathematics (DICATAM), University of Brescia, Italy. She is interested in sustainability at building and district level; environmental and energy protocols, energy saving, renewable energies, energy retrofit, NZEB, BIM to BEM (building information modelling to building energy modelling) interoperability, cognitive buildings, behavioral design, probabilistic models, building management systems (BMS).

#### **Jacopo Muzio Treccani, Contract Assistant**

Department of Architecture and Urban Studies, Politecnico di Milano, Italy. From 2000 to 2003 he collaborated with architect Umberto Riva and Giovanni Drugman and from 2003 and 2008 with Studio Gregotti Associati International. Since 2008 he is Coordinator of the Scientific Committee of the Fondazione Corrente Onlus in Milan. Since 2012 he is a Contract Assistant at Politecnico di Milano in several courses of Architectural Composition (Prof. E. Battisti, Prof. R. Dorigati, Prof. C. Zucchi). Since 2018 he is a member of AICI (Italian Association of Real Estate Consultants, Managers and Valuers) and collaborates with R4M engineering. In 2018 he obtained the title of 2nd level University Master at Politecnico di Milano in Planning, Programming and Design of Hospitals and Socio-Health Systems.



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## Monitoring of Wooden Constructions – A Key to Long Service Life?

### Abstract

Timber constructions are already not limited only to one or two floor buildings. Popularity of natural, renewable, low carbon footprint material is steadily increasing and wooden tall buildings are built over the world. The number of failures and accidents caused by inadequate approach is following the number of wooden building cases. While the natural material offers comfort indoor living environment, it is keeping its natural properties such as sensitivity to humidity and moisture. Monitoring of the construction from beginning is can prevent failures and can extend the service life of the construction and assure its structural health after many years of service. Natural material is sensitive to the conditions in the construction. Commonly used construction types such as cross-laminated timber, glue-laminated timber or timber frame structure can suffer from increase humidity and moisture levels already in short period after commissioning. In case of long term exposure of the wood to increased humidity the decay processes will start and might end up in serious construction damage [1][2][3][4]. It is very hard to detect the problems in early stage since there are usually additional layers on the wood panels or timber frames and thus the timber construction itself can be hidden. Moulds and fungi can cause serious damage and might be hidden for couple of years without and indications in the interior. Such situation can lead to reconstructions that might be equal to 50% of the purchasing price of the house. The effects on the tall buildings is even more serious. Even if the some early warning systems are available on the market today [5], they are not suitable for permanent integration into construction and they rarely used in new constructions. The presentation will show unique set of long-term monitoring data collected from wooden constructions. The data will be processed with respect to dangerous conditions for wooden material and several typical cases of detected abnormal situations in the construction will be shown together with explanation of the reason method of treatment and consequences. The length of data record is 5 years in some of the cases. The datasets are taken from the sensors integrated in the structure directly during construction process and monitored values are recorded directly in the structure itself.

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# **Invited Forum**

## **Day-2**

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## APTES/TiO<sub>2</sub> Nanomaterials for Water Purification

### Abstract

Titanium dioxide (TiO<sub>2</sub>) is one of the most frequently used photocatalysts worldwide. Currently, scientists are exploring new methods of TiO<sub>2</sub> modification to improve its physicochemical properties, thus photocatalytic activity. One of the newer approaches involves the use of organosilane compounds. 3-aminopropyltriethoxysilane (APTES) belongs to the group of aminosilanes and is one of the commonly used organic silane-coupling agents [1].

This work aims to study the impact of calcination temperature on the photocatalytic properties and stability of APTES-modified TiO<sub>2</sub>. The new APTES/TiO<sub>2</sub> nanomaterials were obtained by solvothermal process and thermal modification in an argon atmosphere. The presence of primary amine groups (C–N, Ti–O–Si, Si–O–C, Si–O–Si) and alkyl groups possibly to observe after TiO<sub>2</sub> modification with APTES, was confirmed by FT-IR/DRS analysis. The carbon and nitrogen content decreased with the increase of calcination temperature due to the thermal decomposition of APTES. More importantly, TiO<sub>2</sub> modification with APTES effectively suppressed the phase transformation and the growth of crystallite size of anatase and rutile during the heating process. The unmodified TiO<sub>2</sub> calcined at 900°C consisted of 100% of rutile phase with crystallites size of >100 nm, while sample heat-treated at the same temperature and modified with APTES, still contained 93% of anatase and 7% of rutile phase with crystallites size of 31 and 68 nm, respectively. Additionally, calcination affected the surface characteristics, i.e. the zeta potential values. The photocatalytic activity of the prepared samples was investigated during the decomposition of methylene blue under UV light irradiation. It was generally concluded that the calcination in an Ar atmosphere significantly enhanced the adsorption properties, thus, photocatalytic activity and stability of the obtained nanomaterials.

### Keywords

photocatalysis, titanium dioxide, APTES, methylene blue degradation

### Reference

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This work was supported by grant 2017/27/B/ST8/02007 from the National Science Centre, Poland. The conference was supported by project No. POWR.03.03.00-IP.08-00-P13/18.

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### Biography

Miss Agnieszka Sienkiewicz is a PhD student at the West Pomeranian University of Technology in Szczecin, Poland. She works in the OPUS 14 project UMO-2017/27/B/ST8/02007 in the team of Prof. A.W. Morawski. The subject of her research concerns the use of  $\text{TiO}_2$  modified with aminosilanes for photocatalytic decomposition of organic pollutants present in water.

## P. Rokicka-Konieczna\*

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## APTES-Modified Photocatalysts for Water Disinfection

### Abstract

Photocatalysis with  $\text{TiO}_2$  has come to global attention as a “green” advanced oxidation process, which can be used for water treatment and disinfection [1]. In order to enhance the antimicrobial properties and photocatalytic activity of  $\text{TiO}_2$  photocatalyst under solar light irradiation, many different ways of modification have been widely applied. One of them is  $\text{TiO}_2$  co-doping, i.e. with nitrogen, carbon and/ or silicon, which could result in enhanced photocatalytic activity and specific characteristics compared with single element modification.

The main goal of this work was to investigate the antibacterial properties of  $\text{TiO}_2$  nanomaterials modified with 3-aminopropyltriethoxysilane (APTES) and gain more knowledge into the role of Si-N-C co-modification of  $\text{TiO}_2$  in microbial inactivation mechanisms.

APTES-modified  $\text{TiO}_2$  photocatalysts were obtained by a solvothermal process. The concentration of APTES in the solution used for modification equals from 200 to 500 mM.

APTES modification was carried out successfully what was confirmed by the presence of silicon, carbon and nitrogen in the  $\text{TiO}_2$  structure. It has been observed that the APTES modification caused the improvement of antibacterial activity and the obtained samples were capable of total *E. coli* and *S. epidermidis* inactivation under artificial solar light irradiation. APTES modified photocatalysts affected also the catalase and superoxide dismutase activity, which caused a disturbance in bacteria metabolic system. The strongest photocatalytic activity and the highest variability of antioxidant enzymes activity was caused by  $\text{TiO}_2$  modified with the concentration of APTES equals 300 mM.

This work was supported by grant 2017/27/B/ST8/02007 from the National Science Centre, Poland. The conference was supported by project No. POWR.03.03.00-IP.08-00-P13/18.

### Keywords

photocatalysis, 3-aminopropyltriethoxysilane, APTES, antibacterial effect, water treatment, water disinfection.

### Reference

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### Biography

Dr Paulina Rokicka-Konieczna is currently working as a researcher at Department of Inorganic Chemical Technology and Environment Engineering, West Pomeranian University of Technology in Szczecin, Poland. Doktor's research focuses on antimicrobial properties of  $\text{TiO}_2$  based nanomaterials.



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## Development of the High Performance Concrete for the Reinforced Concrete Columns Strengthening

### Abstract

This paper presents the development and application of new high-performance concrete mixture, developed for the reinforced concrete columns strengthening of the office building in Gabon.

During the construction of a new office building in the center of Libreville, the capital of Gabon, multiples changes of designers and contractors occurred. Originally, the building was designed to have four floors. After the change of contractor, five more floors were added to the building, without any intervention on the already constructed structure. Finally, during the bringing in of the equipment and furniture, cracks appeared on some columns of the first floor, and on some beams. Fearing catastrophic consequences, it was proposed that the entire facility be demolished.

The Client from Gabon required an expertise for the quality and safety of the structure. Detailed structural analysis showed that the existing columns cannot bear the increased load, but also that it was possible to strengthen the columns to achieve the required load-bearing capacity. However, the dimensions of the columns could not be increased by more than 5 cm on each side, which required the usage of high compressive strength concrete, over 60 MPa, with the max. aggregate size of 8 mm. It was necessary to achieve the joint action of new and old concrete.

For the purpose of column strengthening, new concrete mixture was designed on the basis of the extensive laboratory analysis. High strength, high adhesion and self-compacting properties were crucial performances for the success of the strengthening. Concrete specimens were prepared using the materials available at the market and tested. Results of the tests of the material showed that the developed mixture meets all the set requirements. The application of the concrete in 5 cm narrow formwork space were also challenging. Final results of the strengthening showed that both the concrete mixture and the application were successful

### Keywords

high-performance concrete, polymer-modified concrete, compressive strength, bending strength, strengthening of columns.

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## Modeling the Sea Level Rise Impact on Coastal Areas: Krapanj (Croatia) Case Study

### Abstract

Most scenarios on global sea level change during the 21<sup>st</sup> century predict the sea level to rise significantly, from at least 0.3 m up to more than 1 m [1]. The global sea level change is mainly caused by the ice sheet and glaciers melting, and the water thermal expansion. A regional sea level can be additionally influenced by an inland water storage changes, weather, etc., and by the geophysical effects such as the vertical land motion of the coastal area. That is why the sea level changes and their projections often must be considered within engineering, environmental, and the other studies and tasks in coastal areas, especially along the shoreline [2]. To estimate the potential impact of the sea level rise, e.g., detect possible vulnerable coastal areas expected to be flooded with the sea level rise in the future, several parameters have to be computed and integrated [3]. This study encompasses the applied study on modelling the sea level rise impact on the coastal area, based on the case study of the small island Krapanj (Croatia). The modelling was performed by computing the sea level trends and the projections for the 21<sup>st</sup> century from radar satellite altimetry and tide gauge data (data obtained from 1992 onwards) [4], calculating the vertical land motion estimations and their projections from InSAR (Interferometric synthetic aperture radar) Sentinel-2 data, and 3D modeling of the coastal area terrain using the drone mapping. The study gives an overview of the methodology used and the practical results on the detection of the vulnerable areas of the island and the perspective on the future research in the wider area. The results show that the expected impact of the sea level rise is significant and can damage the settlement on the island as well as its cultural and natural heritage.

### Keywords

Climate change, radar satellite altimetry, remote sensing, sea level rise, vertical land motion.

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## Development of The Prefabricated Concrete Houses System for Equatorial African Region

### Abstract

This paper presents the development of new prefabricated elements for housing construction and their possible application in Equatorial African region, specifically in Gabon (Africa).

Initial idea came from the Gabonese Client's request for the prefabricated buildings fabricated overseas (in Serbia) and assembled at the site (Okolassi, Gabon). The main problem was to achieve small weight but sufficient strength and robustness of the panels and assembled house.

New concrete panel types were developed in order to satisfy the following conditions:

- Panels, with dimensions 240-360 cm (length), 110 cm (height), and 15 - 20 cm (width);
- Panels should weigh up to 100 kg/pc, and yet be sound and robust;
- When assembled, panels must form a load bearing structure for one and two floors houses.

In order to meet all the requirements, panels were designed with lightweight core (made of mineral wool or EPS) and strong finishes (high-performance concrete casted layer).

Structural analyses of the panels and of the assembled structure were performed. On the basis of those analysis, several panel prototypes were casted using the materials available at the market and tested in situ. A prototype of assembled house was constructed. The results of this project showed that new concrete panels system is cost effective and appropriate for the use in affordable housing projects.

### Keywords

concrete, high performance concrete, concrete prefabrication, load bearing concrete wall panels.

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## Exploring the Renewable Energy Potential from Below Ground Level

### Abstract

The global concerns regarding the climate change and planet resources have generated new policies and trends that have started transforming the building sector landscape. According to statistics, buildings account for approximately 40% of the worldwide annual energy consumption. Therefore, integration in the new buildings of innovative solutions to ensure renewable energy sources and efficiency in a sustainable manner represents a current and major challenge. In this context, geothermal energy represents one of most complex renewable energy domains with many various possible applications. The paper presents an innovative solution for renewable energy generation that can be easily incorporated in the new buildings that is represented by energy geostructures. As part of shallow geothermal energy systems, energy geostructures provide significant benefits for the new buildings such as decreased building operational energy costs and significant contributions regarding CO<sub>2</sub> emissions reductions. The paper describes the concepts behind this technology, how it can be incorporated in a variety of structures and highlights the advantages and the challenges for its implementation.

### Keywords

renewable energy, sustainability, energy geostructures, nZEB buildings

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## **Sustainable Project Proposals for the Development of Internal Areas: Best Practices in the Heart of the Cilento National Park, Italy**

### **Abstract**

The progressive abandonment of internal populations has led, in Italy as in other European and non-European countries, to the promotion of strategies, at national level, for the reactivation and repopulation of these geographical areas. The purpose is to attract investment and dynamically repopulate these areas, which is possible if the territory is able to offer adequate levels of quality of life that include services, work, attractions, leisure and not least a boost in tourism. This study intends to assess, specifically, the area of Cilento (Province of Salerno, Italy) subject to the National Strategy for Internal Areas (summarised in the acronym SNAI) by analysing and comparing three sustainable project proposals, best practices, which propose a territorial revitalisation through the development of new attractions with consequent entrepreneurial opportunities.

### **Keywords**

Sustainable Development, Low-carbon Tourism, Valorisation, Landscape Planning

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## Impacts of Earthquakes in 2020 to Croatian Cultural Heritage

### Abstract

Year 2020 was devastating for the Republic of Croatia in many ways. While the country was struggling with the Covid-19 pandemic, Mw5.4 earthquake struck its capital Zagreb in March, causing one fatality and high economic losses, estimated at more than 10B euros. The most affected was the historic center, where many cultural heritage buildings, such as the Zagreb Cathedral, were seriously damaged. Rapid post-earthquake inspections of damage and usability had been performed for more than three months, and by the end of the year the government completed the legislative and prepared financial aids for reconstruction. Unfortunately, on December 29 the Mw6.4 earthquake, preceded by three strong foreshocks the day before, occurred near the town Petrinja located approximately 50 km SE of Zagreb. This was the largest earthquake in Croatia since the introduction of modern seismic instrumentation, resulting in 7 fatalities and widespread damage. Among other locations, historic centers of three towns, Petrinja, Sisak and Glina, were seriously affected, with many heavily damaged and collapsed private and public buildings, such as schools, churches, etc., mostly of URM typology. Furthermore, this earthquake caused progressive damage to buildings in Zagreb. In total, more than 48,000 damage assessments have been performed until the mid-June 2021. Focus will be on the typical observed damage to the cultural heritage buildings.

### Keywords

masonry buildings; damage; cultural heritage; post-earthquake building inspections; COVID-19 pandemic

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## **AMASS: Advancing A System for Manufacture and Assembly of Structural Steel**

### **Abstract**

Investigation of an “Intermeshed Connection” for gravity load resistance in steel frame structures lays the groundwork to transform the steel building construction industry by advancing the underlying science and engineering precepts for connections created by precise, volumetric cutting using advanced manufacturing techniques, such as high-definition plasma and water jet. The AMASS (Advanced Manufacturing for the Assembly of Structural Steel) intermeshed connection exploits this potential by means of precise steel pieces that can intermesh (i.e. interlock) with each other and form a connection. Load transfer is mainly through direct contact of the connection components rather than by traditional means through welds or bolts, which facilitates fast assembly and disassembly of steel structures and material reuse. The study provides insight on structural performance at both global and local levels, and investigates appropriate design methods. Numerous intermeshed connection details for beams were considered, a design procedure was developed, physical specimens were tested, and beams with intermeshed connections were analyzed. Load resistance and design of these connections were explored to evaluate stress and strain concentrations, effective material utilization, failure modes, and connection geometry optimization. The intermeshed connection demonstrates ample load carrying capacity, stiffness, and ductility, and promises to be robust, secure, and dismountable. It offers the ability to be manufactured within current industrial tolerances and be erected quickly.

### **Keywords**

analysis, beam connections, design, manufacturing, structural steel, testing



# **Poster Presentation** **Day-2**



## Juan Manuel Bueno Carvajal

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## Emerging Architecture of Public Space: Possible Urban Alternatives in the Covid-19 Crisis

### Abstract

Through the course of the present century, it is possible to find emerging forms and structures of public space in cities that question the traditional ways of their architecture, management, and meaning. These forms have been taken into consideration to face the current sanitary emergency of the cities caused by the COVID 19 pandemic. With this antecedent, the present research aims to contextualize and define these emerging forms, create questions about the relevance and evolution of these practices, explain their potential in facing the COVID-19 crisis, and build reflections on their importance and contribution in terms of health and sustainability for cities and architecture.

This emerging public space can be defined by three components. In the first place, recycling as a constructive form, which includes recycled elements as a raw material in efficient and sustainable processes that have the capacity for self-construction and to reduce costs. In the second place, the development of tactical urbanism as a method that allows temporary projects to be carried out within the reach of citizens. And the third, the citizen participation as a democratic method for design, development and construction.

The current emergency has affected cities, disturbing the urban social experience, exalting inequality, generating greater risk for the most vulnerable citizens, having in mind that the fewer quality public spaces citizens have, more chances of exposure. As the immunization process progresses with vaccines and pharmacological treatments, widespread attention will be needed to be able to implement social distancing measures effectively to reduce the transmission of SARS-COV-2. This emerging architecture is determinant to assume new interventions in favor of health since it gives the priority to development and the encounter with the public in open spaces as an opportunity for new socializations and regeneration platforms, especially from neighborhood scales where it is possible to act through the participation of neighbors and communities.

As a result, three relevant contributions can be defined: first, the understanding of the well-being function offered by public space from the meaning of health; second, the opportunity to make more flexible spaces in cities from tactical actions allowing the inclusion of simple structures to generate more outdoor activities; and third, the potential of streets to develop sustainable mobility - on foot and by bicycle -, their versatility, and to provide space for pedestrian activities. It can be concluded that in this crisis, these alternative forms can be consolidated to create public spaces that are safer in the face of emergencies, supportive to reactivate the local economy, and adaptable to promote outdoor activities. The evolution and development of these forms is an actual discussion of the possible lack of governments' will, the obstacles in urban and construction regulations and laws, or the private sector influence about the use of public space.

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## The Role of Carbonate-based Barrier in Thin Surface Plaster Layer of 100-Year-old Bridge Concrete

### Abstract

The chemical reaction of cementitious constituents in concrete, primarily calcium hydroxide also known as portlandite  $[\text{Ca}(\text{OH})_2]$ , and atmospheric carbon dioxide ( $\text{CO}_2$ ) cause chemical changes in the concrete, resulting in a pH reduction. This process is known as carbonation. Chemical changes in concrete by carbonation results in the reduced porosity, which reduces permeability and increases the microhardness of the cementitious matrix. The alkalinity of the concrete is reduced below pH 9, which is no longer able to provide protection to the steel reinforcement against corrosion. In-situ research and laboratory examination provided on concrete core samples from old bridge structures confirmed that a thin layer of ordinary cement-based render coat protects the underlying concrete from carbonation. The average measured value of carbonation depth by phenolphthalein test was less than 2 mm after more than 100 years of service life. Low carbonation depth is explained by the presence of a thin (2 - 4 mm) layer of the protective render coat (PRC) situated on the bridge concrete. The place, where the PRC was of good quality was almost impermeable and the carbonation of the concrete underneath was even 0 mm. If the PRC locally spalled, the carbonation depth of the same concrete, at the same structure and environment reached at this place even more than 80 mm. Carbonation depth of the underlying concrete depends upon the non-permeability of the PRC. The very low permeability of the PRC is caused by the accumulated carbonates in a narrow spatial area of the PRC. The formed carbonate-based barrier called “carbonation milk” condenses the space up to creating the impermeable barrier for  $\text{CO}_2$ . The article also aims on the effort to apply the knowledge gained by the research to increase the service life of existing concrete bridges with small reinforcement cover, and on the effort to develop an equally effective barrier made from today's materials.

### Keywords

carbonation, concrete, render coat, bridge

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## The Sol-Gel Synthesis and Photocatalytic Activity of $\text{TiO}_2/\text{SiO}_2$ Photocatalysts

### Abstract

Increased environment pollution has become the motivator for inventing more effective purification methods such as various biological and physicochemical processes. Heterogeneous photo catalysis with the use of titanium dioxide may be one of the methods of increased efficiency for removing harmful pollutants from water. In this work, an attempt was made to obtain new photo-catalysts based on titanium dioxide modified with colloidal silica to increase the photocatalytic activity in relation to model organic water impurities. An aqueous solution of methylene blue dye was used as model pollutant. Photocatalysts were obtained with the sol-gel method, using titanium(IV) isopropoxide as a precursor of  $\text{TiO}_2$  and colloidal silica. The obtained gel was dried in a muffle furnace at  $100^\circ\text{C}$  for 24 hours. After drying, the sample were calcined at various temperatures ( $400\text{--}800^\circ\text{C}$ ,  $\Delta t = 200^\circ\text{C}$ ) in a tube furnace in the argon atmosphere. The analysis of the obtained results showed that the adsorption-desorption equilibrium was reached after 1 hour. For all samples a slight methylene blue adsorption (approx. 2-5%) was noted. First of all, it was found that all photocatalysts modified with colloidal silica show higher decomposition degree of methylene blue (MB) under UV light than the pure  $\text{TiO}_2$  prepared via the same method. Secondly, the photocatalytic activity increases with the increase of colloidal silica content used for modification. The highest activity in photocatalytic degradation of MB was obtained while using 7.7 wt.% of colloidal silica. The increase in photocatalysts  $\text{TiO}_2/\text{SiO}_2$  activity can be attributed to higher content of the anatase phase. Furthermore, using colloidal silica as a silicon precursor results in obtaining materials with a larger specific surface area and pore volume. It was also noted that with the increase of annealing temperature the photocatalytic activity increases. The  $\text{SiO}_2\text{-}7.7/\text{TiO}_2/600$  sample showed 76% methylene blue removal in contrast to the  $\text{TiO}_2$  (sol-gel)/600 (removal rate to 34%). It was most likely caused by increase of the anatase crystallites size.

### Keywords

photo-catalysis, titanium dioxide, colloidal silica, methylene blue decomposition, sol-gel

*The conference was supported by project No. POWR.03.03.00-IP.08-00-P13/18.*

### Biography

MSc Aleksandra Babyszko was graduated in 2016 from Chemical Technology and Engineering at the West Pomeranian University of Technology in Szczecin, majoring in chemical and process engineering with a specialization in process engineering. She is currently working on completing a doctoral thesis, which focuses on purifying water from organic pollutants using the silicon-modified titanium dioxide.



# **Plenary Forum**

## **Day-3**

## Venkatesh Kodur

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## Innovative Strategies for Enhancing Fire Performance of High Performing Materials and Structural Systems

### Abstract

Fire represents one of the most severe environmental hazards to which buildings and built infrastructure is subjected, and thus provision of appropriate fire safety measures for structural members is a major requirement in design. Currently, fire resistance of structural members is mostly evaluated through either standard tests or prescriptive based methodologies. In recent years there is growing recognition that the current prescriptive approaches have serious drawbacks and limitations and do not provide realistic assessment of fire performance. To overcome these drawbacks, performance-based fire design approach is being promoted. Undertaking such performance based design requires validated numerical models and reliable input data on many factors including realistic fire scenario, load level, boundary conditions, and high temperature material properties.

Over the last three decades, there have been significant research and development activity in improving the strength and durability properties of construction materials. This research has led to the development of a new class of construction materials, often referred to as high performing materials (HPM), (e.g. high strength concrete (HSC), fibre reinforced polymers (FRP), fibre reinforced concrete (FRC), structural multilayered glued wood (engineered wood), high strength steel (HSS), and light gauge steel). These HPM's offer attractive alternative for realizing cost effective, durable, and high performing structures in built environment. Also, materials such as FRP and FRC are highly effective in strengthening and retrofitting of aging and deteriorating infrastructure.

While these HPM's have high strength and durability properties at ambient temperature, their performance under fire (high temperature exposure) are highly questionable. Many of the new materials have poor or unknown fire characteristics, and their fire performance, when integrated into structural systems, is not well understood. For instance, newer types of concrete (HSC) are found to be more susceptible to fire induced spalling. FRP's are generally combustible and lose their structural functionality at moderately low temperatures through bond degradation. Engineered wood has lower fire resistance as compared to conventional wood due to the presence of adhesives, a rapidly combustible petroleum-based material. HSS and Light gauge steel is highly susceptible to local buckling under fire conditions and also adhesion of fire insulation is a major concern. Addressing these fire performance issues is critical for effective utilization of HPM in building and other structural applications.

In the presentation, fire performance problems associated with HPM are discussed. The lack of high temperature property data for these HPM will be highlighted. Examples of innovative strategies for enhancing fire performance of HPM and structural systems will be presented. Specific guidelines such as the use of bent ties and/or fibres to mitigate fire induced spalling in HSC and use of

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effective insulation schemes for enhancing fire resistance of FRP-strengthened members will be discussed. Through case studies it will be demonstrated that accounting for realistic parameters, such structural continuity, membrane action, end restraints, and realistic fire scenarios, can improve fire performance of structural systems. Finally, research needs for advancing the state-of-the-art relating to fire performance of high performing materials and structures will be presented.

### **Keywords**

High performing materials; structural systems; high strength concrete, fire resistance; performance-based design; high temperature properties.



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## **Applications of composite steel-concrete structures for civil, architectural and environmental engineering**

### **Abstract**

Composite steel-concrete structures have provided outstanding examples of benefits in civil and architectural engineering. The genesis of composite construction lies at the turn of the 19<sup>th</sup> and 20<sup>th</sup> century with the advent of the modern skyscraper. The use of structural steel columns and the practical need to provide adequate fire resistance for such members inadvertently saw the use of composite stiffness and strength developed. It would be perhaps 50-60 years later that proper quantification and standardization of these increased stiffnesses and strengths have been utilized. The initial development and patenting of the shear stud saw the advent of composite action between steel beams and concrete slabs for bridge structures and other civil engineering applications in the mid 20<sup>th</sup> century. This was expanded to floor construction in architectural applications and composite beam behaviour provides enormous benefits for modern multi-storey construction. The enormous benefits that juxtaposing concrete with steel provides ensures that it is an optimal system for the future. Concrete provides stiffness and also assists to arrest many of the stability problems associated with steel structures, namely local and global buckling problems. Composite systems lend themselves to demountability and deconstruction which is extremely important in future sustainability initiatives of civil and architectural applications. Composite systems of the future lend themselves to the use of high performance concrete and high performance steels. The use of geopolymer concretes provides enormous environmental engineering benefits, however they are also shown to have significant benefits in terms of durability and fire performance. The use of high performance steels, namely high strength, stainless and clad steels, also lend themselves to being able to be justified on life cycle grounds.

### **Keywords**

Architectural engineering, composite construction, civil engineering, environmental engineering, high performance concrete, high performance steels

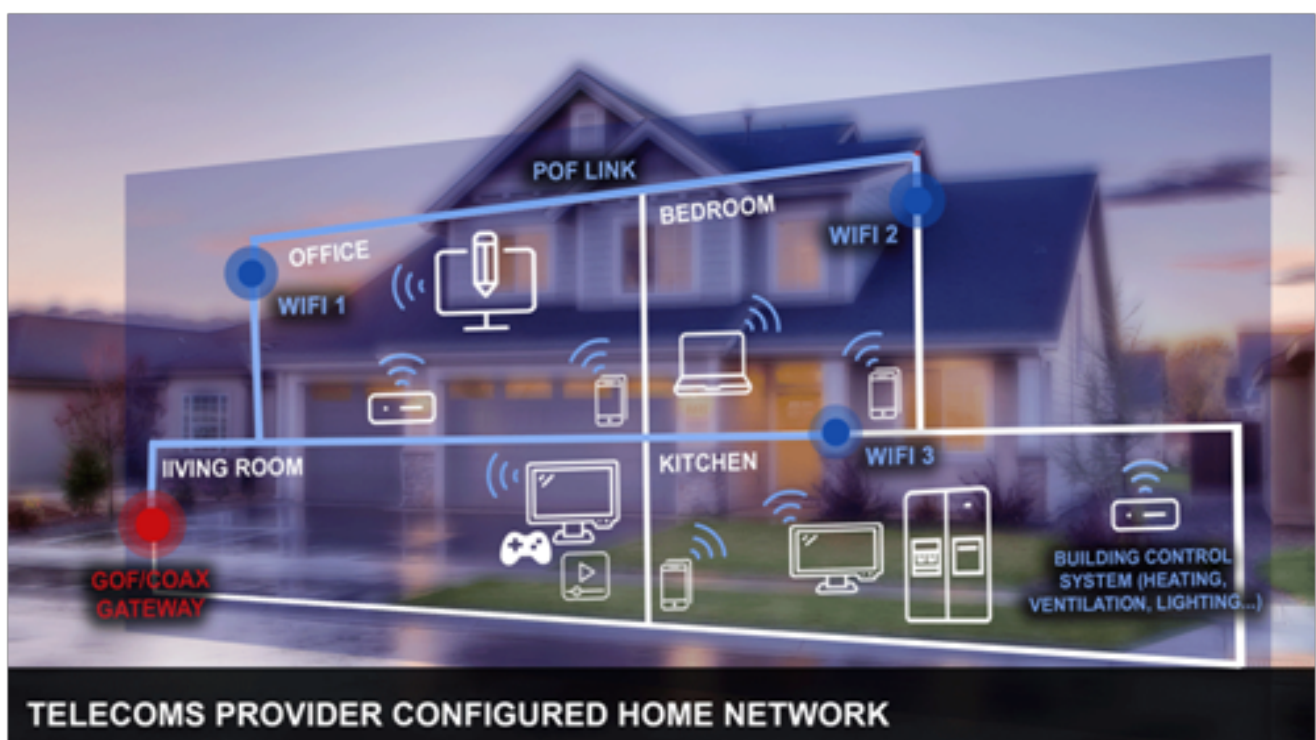
## Mohd Syuhaimi Ab Rahman

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## High Speed Solution for In-Building Network Infrastructure

### Abstract

Polymer Optical Fibers (POFs) replace traditional communication media such as copper and glass step by step within short distance communication systems, mostly because of their cost-effectiveness and easy handling. POFs are used in various fields of optical communication, e.g. the automotive sector or in-house communication. The current “state of the art” are single mode communication systems. These systems use only one wavelength for communication, which limits the bandwidth. For future scenarios, this traditional technology is the bottleneck of bandwidth (e.g. for HDTV with IP-TV). One solution to surpass this limitation is to use more than one wavelength over one single fiber, a technique known as WDM (wavelength division multiplexing). This multiplexing technology requires two more technical key elements: a multiplexer, which combines the multi-wavelengths signals into one fiber and a demultiplexer at the end of the network to separate the colored signals. This presentation discusses the overall POF technology for small world communication from device fabrication, device types, configurations and applications. Our solution supports the basis of a wavelength division multiplex (WDM) system in the visible spectrum. Discussion will focus on the technologies that have been developed in our laboratory concerning user friendly approach, ease of maintenance, safety and high-performance solution.



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## Biography

Mohammad Syuhaimi Ab-Rahman began his career at Universiti Kebangsaan Malaysia (UKM), in mid-2007 as a lecturer and appointed as a senior lecturer in early 2008. In January 2010, he was appointed as Associate Professor in the Department of Electrical Engineering, Electronics and Systems. His specialization is in the field of electronic engineering specifically in optical communication system. He has been involved in many impact researches, academic writing, teaching, supervision,

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leadership positions, registered prototype and innovation, policy development and community services. He was promoted to full Professor at the age of 33 years old; which is very young and rare in Malaysia. This has demonstrated his outstanding personality and contribution to the field of science and technology. He was Deputy Dean Academic in Faculty of Engineering and Built Environment before been promoted to Director of Alumni Relation Center, Universiti Kebangsaan Malaysia. He is also professional engineer registered under Board of Engineering Malaysia.

To date, he has produced more than 13 PhD graduates, 16 Master of Science students, 286 journal articles, 196 proceeding, 18 books, 10 chapter in book. 24 awards/medals for science and technology exhibitions, 6 granted research patents, lead more than 10 impact research with cumulative MYR 4 million, head more than 5 impact community programs, held more than 10 administration positions, and involved in more than 5 important committees (e.g., Program Accreditation Evaluation Panel for Washington Accord EAC & ETAC, Malaysia Academic of Science).

During his tenure at UKM, he was appointed as the appraiser grants Industrial Grant Scheme (IGS) and was involved in giving advice to the Ministry of Health in the assessment of the use of Long-Range Acoustic Device (LRAD) before they are brought into Malaysia. He is also active in giving motivational talks to university students as well as speakers for Malaysia Ministry of Higher Education (MOHE) to guide the new lecturers/researchers in conducting research.





# **Keynote Forum**

## **Day-3**

## Cristian Maluk

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## Structural Fire Engineering: A Growing Need for Innovation

### Abstract

Whether explicitly acknowledged or not, modern structural engineering and building design can be strongly influenced by fire safety considerations. Within an environment of future thinking innovation, guaranteeing appropriate performance of structures during or after fire often results in an obstacle for completely fulfilling the drivers for research and development. For example, medium-rise or relatively large engineered timber structures are often encapsulated using fire rated boards for the purpose of achieving fire safety design objectives and requirements.

A careful understanding of the first principles behind structural fire engineering and the science of materials at elevated temperatures reveals the value of integrating fire performance as one of the many variables to optimize in structural engineering design. Moreover, experience has demonstrated that when structures fail during or after a fire, is usually for reasons that would not (or could not) have been expected on the basis of the structural fire engineering design or analysis performed. Whether it is high performance concrete that is known to have a higher propensity for explosive spalling during fire or steel structures that fail due to relatively complex fire-induced forces and stresses; poor understanding of their impact in structural behaviour may result in the delivery of sub-optimal solutions or the potential for unexpected failure.

This work examines how innovations in structural engineering (and the broad built environment) may lead to problems in fire safety, and how structural fire science and engineering can be used as a generator to deliver new structural systems and approaches. A range of relevant research topics and areas of interests are shown within the scope of this work.

### Keywords

structures, fire, innovation, challenges.



## Mehrdad Arashpour<sup>1\*</sup>

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## Deep Learning and its Applications in Construction

### Abstract

Deep learning methods have significantly advanced computer vision in tackling a variety of tasks such as object detection, semantic segmentation and pose estimation. One of the most prominent contributing factors to the substantial performance improvement of deep learning is the availability of large, accurately labelled, and diverse datasets, required for training deep neural networks. While computer vision has proved to have a wide range of applications in construction management, limitations in availability of large datasets, as well as the manual and labour-intensive process of data labelling impede practical application of such methods in the industry.

To address this limitation, a framework is proposed for automatically generating synthetic datasets to train a deep neural network for the task of construction equipment pose estimation. The method is developed in a simulated environment that implements domain randomization to generate diverse, large and accurately labelled training datasets. The method can be used in a variety of applications such as object detection and semantic segmentation.

### Keywords

Computer Vision, Construction Engineering and Management, Convolutional Networks, Deep Learning, Object Tracking, Pose Estimation

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- [3] C. Feng, V. R. Kamat, H. Cai, Camera marker networks for articulated machine pose estimation, *Automation in Construction* 96 (2018) 148-160

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## Recent Trends of 3D City Modeling in Built Environment

### Abstract

One of the latest areas of knowledge from the field of Three-dimensional Geographical Information System (3DGIS) is the 3D City Modeling (3DCM). Although 3D modeling has long existed, but due to the pressure of technology like the 4th Industrial Revolution (4IR), conventional 3D modeling needs to be evolved. With the advancement of Artificial Intelligent (AI), multiple sensors, advanced cameras, human navigation and interactions towards smart city advancement, it requires an efficient city modeling approach. 3DCM is an accurate and efficient 3D city modeling technique as it is developed based on international standards (Open Geospatial Consortium and ISO TC211). 3D city modeling is the foundation in development of Smart City in the future. It is believed that with a strong foundation, the development of future smart applications for the cities can be easily developed. In this research, the latest trends related to 3DCM in the field of built environment are shown. The area of the built environment covers the latest research done in the field of 3D data acquisition, 3D standards and 3D modeling. As for applications it ranges from construction management, Building Information Modeling (BIM), environmental modeling and asset management. As this 3DCM is growing, the involvement of various research groups in many fields is needed to realize the objectives towards a more structured, efficient and safe city management for humans and the environment.

### Keywords

3D City Modeling, 3D GIS, 3D Standards, BIM, Environmental Modeling

## Olga Fink

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## Decision Support System for an Intelligent Operator of Utility Tunnel Boring Machines

### Abstract

In tunnel construction projects, delays entail high costs. Thus, tunnel boring machine (TBM) operators aim for high advance rates without compromising safety, a difficult mission in uncertain subterranean environments. Finding the optimal control parameters based on the TBM sensors' measurements remains an open research question with significant practical relevance.

In this talk, we will present an intelligent decision support system developed in three steps. First, we propose an optimality score to evaluate TBM operation performance, taking into account the advance rate and the working pressure safety. A deep learning model then learns the mapping between the TBM measurements and this optimality score. Finally, in the context of a real application, the model provides incremental recommendations in order to improve the optimality, taking into account the current setting and measurements of the TBM.

The proposed approach is evaluated on a real micro-tunneling project and demonstrates great promise for future applications.

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## The Current State of Hydropower Plants in Taiwan

### Abstract

The first bulb lighted up in Taiwan on August 17th, 1905, using electricity generated by the first hydropower plant. Until the beginning of rapid industrialization, the hydropower sector remained to lead the electric generation in Taiwan. In 1962 the installed capacity of thermal power plants finally surpassed the hydropower plants.

Despite the constant natural threats, hydropower continues to be the leading renewable source of energy. The current overall installed capacity in all hydropower plants is above 4,402.207MW. At the same time, 2602MW is in the 2 pumped storage hydropower plants [1].

In 1995 Taiwan concluded the first and only hydropower potential investigation report. The results were that the theoretical hydro energy potential in Taiwan equals 11,730MW and the feasible potential is 5,000MW.

In 1995 the Independent Power Plant (IPP) act was approved, starting the Taiwanese energy market liberalization. Several private companies commenced their hydropower projects. In 2019 Taipower got 26 contracts and overall annual purchased power 294MW only from hydro and other renewable energy IPPs (excluding Wind and Solar) [2].

Since 2015 hydropower development took once again a faster development pace, but mostly in small scale sector.

In 2020 Taiwan hydropower network consists of 4 main areas, 12 branches, and 49 operating units. A compelling are micro and pico hydropower plants serving mostly as a supporting power generation to cut down the local farmers' electricity bills.

The notable fact is that despite the constant modernization from all the currently operable units, 26 are considered historical. The localization of the historical hydropower plant sites is part of the research initiative that started in 2012 regarding the very first complex mapping of Taiwanese hydropower plants. The physical excavation is running since 2016. So far, the research successfully located over 10 historic sites.

### Keywords

Energy, Hydropower, Hydropower plants, Taiwan, Water.

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### Biography

Stefan Tkac is an Associate professor, and chair of Architecture and Civil Engineering at the American University of Phnom Penh (AUPP).

He is also a founder and CEO for the Architectural and Design firm STUDIO Ltd.

Stefan holds dual PhD in both the Theory of Designing Buildings and Environment, and Civil Engineering from the Technical University of Košice, Slovak Republic and Chung Hua University, Taiwan R.O.C.

Additionally, he holds the EUR ING title from FEANI and runs the Slovak-Taiwan hydro energy research lab along with being a valid member of the Asian Network of Industrial Heritage.

He is the first person who did the complex on-site mapping of the Taiwanese hydropower plants including the excavation and restoration of the industrial heritage sites.

## Hexin Zhang<sup>1</sup>

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## Torsional stiffness of the laminated glass beams

### Abstract

In this study, a concise concept was proposed for quantifying the shear/torsional stiffness of the laminated glass beams experimentally by introducing the Equivalent-Sectional Shear Modulus (ESSM), that is directly measured from the torque and sectional-rotation correlation with the torsion test and tailor-made photogrammetry technique. The advantage of this method is to measure the actual rotation to torque response revealing the actual torsional stiffness. This eliminates the uncertainties of analytical approximations that are commonly adopted by most existing methods in which the composite shear/torsion stiffness is derived from its component mechanical properties. The photogrammetry technique increased the accuracy of the sectional rotation measurement by acquiring dense displacement sample points on the glass beam simultaneously. The accuracy of the photogrammetry setup and efficacy of the test design were proven by a micrometre and a monolithic glass beam test. One sample each for the polyvinyl butyral (PVB) and SentryGlas Plus (SGP) laminated glass beams were tested multiple times non-destructively to determine the ESSM. The result of the PVB laminated glass beam showed close agreement with the previous studies, however the result of the SGP laminated glass beam suggested a great larger difference from the previous studies. It also suggested that mechanical properties of the interlayer played an important role in the composite behavior of the laminated glass beam. The experimental outcomes have demonstrated the proposed method is an accurate and effective technique for measuring the ESSM of laminated glass beams.

### Keywords

Laminated glass beam; equivalent-sectional shear modulus; Glass beam torsion test; Photogrammetry method for glass structures.

### Biography

Dr Zhang joined Edinburgh Napier University in 2004, as a Senior Research Fellow, following a PhD in Civil Engineering from The Hong Kong University of Science and Technology and a three-year practice as a structural engineer in China. He became a chartered engineer in China in 1999, a lecturer in 2005 and associate professor in 2018.

Dr Zhang research focuses on engineering bamboo-timber composite in construction, laminate glass structures and pre-stressed steel-reinforced concrete structures in complex loading conditions. He has extensive experiences in using the photogrammetry technology and multiple sensor systems in civil engineering studies. He is also an experienced computer programmer who developed several design software packages for trusses and scaffolding structures.



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Dr Zhang has led several research and knowledge transfer projects funded by the Royal Academy of Engineering, Scottish Founding Council, Innovation UK, British Council, etc. His research has been published widely in both highly ranked civil engineering journals and conference proceedings. He is member of CEN/TC 124/WG-1 committee for European Standard: EN408 review and revision.

## Ning Lin

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## Hurricane Risk Mitigation in a Changing Climate

### Abstract

Hurricanes, with their strong winds, heavy rainfall, and storm surges, cause much damage and loss of life worldwide. The impacts of these storms may worsen in the coming decades because of rapid coastal development coupled with sea-level rise and possibly increasing hurricane activity due to climate change. Here we present a holistic framework of modeling hurricane hazards and risk and apply the framework for the development of risk mitigation strategies: (1) flexible adaptation design concerning the existence of deep uncertainties in climate science and the benefit of continuous learning and updating, and (2) power grid retrofit for combating hurricane-blackout-heatwave compound hazard risk in a changing climate.

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## Geomechanics in the Geological Disposal of Radioactive Waste

### Abstract

Since 1978, the Canadian Nuclear Safety Commission (CNSC), Canada's nuclear regulator, has been involved in collaborative research focusing on long-term safety issues related to the geological disposal of radioactive waste. Geological repositories rely on multiple barriers (the waste form, container, engineered seals, and host rock) for the containment and isolation of radioactive waste for periods of hundreds of thousands to one million years. The CNSC's research program looks at the long-term performance of those barriers. In this keynote presentation, we will focus on geomechanical issues related to the engineered seals that surround the waste containers in the emplacement rooms and the host rock formation that is the ultimate barrier between the waste and the surface environment. Specifically, we will:

- i) Describe the safety functions played by the engineered seals and the host rock to provide long-term protection of the surface environment
- ii) Provide research examples on geomechanical processes that have impact on those safety functions: swelling potential of bentonite seals; fault re-activation from water injection; and the hydromechanics of intact granite.

### Keywords

radioactive waste, geological disposal, geomechanics, fault, granite, bentonite.

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# **Invited Forum**

## **Day-3**

**H.Y. Zhao\***

ARC Industrial Transformation Training Centre for Advanced Technologies in Rail Track Infrastructure (ITTC-Rail), University of Wollongong, NSW 2522, Australia

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## Laboratory and numerical investigations into the vulnerability of railway subgrade to mud pumping

### Abstract

Subgrade mud pumping (fluidization) due to the passage of heavy haul and high-speed trains have been critical issues for ballasted railway tracks over many years. In this study, a series of undrained cyclic triaxial tests were carried out to investigate the dynamic performance of railway subgrade soil prone to mud pumping at various train loading frequencies and freight capacities. The results demonstrate that the subgrade soil is more vulnerable to mud pumping at small train speeds with higher axle loads (i.e. heavy haul) when there is a sudden rise in the plastic strain within limited number of loading cycles, which occurs in conjunction with a drop in the deviator stress in the stress path. According to the experimental observations, a constitutive model was developed within the framework of generalized plasticity theory. Comparisons between the model responses and experimental results indicate the capabilities of the developed model in terms of predicting the stress-strain behaviour of the subgrade soil prone to mud pumping. The proposed constitutive model was further incorporated into a finite element framework to investigate the plastic/dynamic characteristics of railway subgrade subjected to moving axle loads. The results show that the stress path corresponding to the applied moving loads exhibits a series of heart-shape envelopes along which the deviator stress and mean effective stress gradually decrease with the successive loading cycles. The build-up of pore water pressure and the associated soil deformation are exacerbated when the train speed approaches a critical velocity of the saturated subgrade. As a practical guide, the influence of permeability of the capping layer is highlighted in relation to controlling track settlement for a given operational train speed.

### Keywords

Mud Pumping; Railway Subgrade; Moving loads

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## **Spatial Analysis, Interactive Visualization and GIS-Based Dashboard for Monitoring Spatio-temporal Changes of Hotspots of Bushfires over 100 Years in New South Wales, Australia**

### **Abstract**

The 2019–2020 bushfire season is estimated to be one of the worst fire seasons on record in Australia, especially in New South Wales (NSW). The devastating fire season ignited a heated public debate on whether prescribed burning is an effective tool for preventing bushfires, and how the extent of bushfires has been changing over time. The objective of this study is to answer these questions, and more specifically to identify how bushfire patterns have changed in the last 100 years in NSW. To do so, we conducted a spatio-temporal analysis on prescribed burns and bushfires using a 100-year dataset of bushfires. More specifically, three research questions were developed, with each one of them addressed differently. First, generalised linear modelling was applied to assess the changes in fire patterns. Second, a correlation analysis was conducted to examine whether prescribed burns are an effective tool for reducing bushfire risk. Third, a spatio-temporal analysis was applied to the bushfire location data to explore spatio-temporal clusters of high and low values for bushfires, known as hotspots and coldspots, respectively. The study found that the frequency of bushfires has increased over time; however, it did not identify a significant trend of change in their size. Based on the results of this study for the relationship between prescribed burns and bushfires, it seems impossible to determine whether prescribed burns effectively reduce bushfire risk. Thus, further analysis with a larger amount of data is required in the future. The results of the spatio-temporal analysis showed that cold spots are propagated around metropolitan areas such as Sydney, while hotspots are concentrated in rural areas such as the North Coast and South Coast regions of NSW. The analysis found four statistical areas that have become new bushfire frequency hotspots in the 2019–2020 bushfire season. These areas combined have about 40,000 residents and at least 13,000 built dwellings. We suggest that further analysis is needed in the field to determine if there is a pattern of movement of bushfire towards metropolitan areas. To make the results of this research accessible to the public, an online interactive GIS-based dashboard was developed. The insight gained from the spatial and temporal analyses in this research is crucial to making smarter decisions on allocating resources and developing preventive or mitigating strategies.

### **Keywords**

Emerging hotspot analysis; geographic information systems; smart cities; data-driven decision-making; dashboard; space-time cubes; climate change

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## Optimising Pavement Evaluation System Using Innovative Technique

### Abstract

Road networks are the main artery of prosperity for any city. Accordingly, the growth and development of any country are classified according to several essential indicators: road networks accessibility, road networks quality, road health conditions, and comfort of road user. Therefore, in order to achieve the sustainability of the urban and rural road networks, significant and standard monitoring, evaluation, and prediction systems of road pavement conditions are needed to be applied to identify the health status and level of damage on road pavement surfaces. After that, transport agencies can apply appropriate maintenance and treatment actions. Several factors affect the sustainability of the road health status, such as the quality of the materials used, pavement age, number of overlays, traffic conditions, and weather conditions. High-quality pavement and comfort riding for roadway users can be satisfied by implementing routine monitoring and maintenance to determine the type and severity of surface anomalies. Maintenance implementation mainly depends on the outcomes of field monitoring of road surface conditions. In this research, dynamic monitoring is applied in Melbourne's different local roads, using pavement vibration data to evaluate pavement health status and determine the type and severity of surface degradation. This study focuses on exploring a new pavement monitoring and prediction model, depending on a dynamic monitoring system and image processing of pavement degradation. This study uses high-quality sensors to measure the vibrations of degradations on road pavement surfaces. A video camera is also used to identify the shape and severity of pavement distresses.

### Keywords

Pavement Monitoring, Vibration, Condition, distress, degradation

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## Uncertainties Handling for Damage Detection Using Vibration Data

### Abstract

Damage detection using vibration data is proven by many studies to be efficient in detecting damage in structures. Time domain, frequency domain and modal domain data are always used as the parameters to detect the existence of damage. However, the existence of unavoidable uncertainties such as modeling error and measurement error may lead to false results. Modeling error is from inaccurate baseline model (finite element model) and nonlinearity effect that makes the model unable to represent exactly the properties of the actual structure. On the other hand, the measurement error is the error that affected the measured data by systematic error and environmental factors. Therefore, the true information that submerged within both errors limits the efficiency of vibration-based damage detection in practice. This presentation highlighted three types of methods to consider the existence of uncertainties in vibration data. The methods are statistical method, non-statistical method and artificial intelligence method. For the purpose of demonstration, several types of structures are used and the relationship between the vibration data and damage information are established using Artificial Neural Network. Through these methods, it is proven that by considering the existence of uncertainties appropriately, the vibration-based damage detection method can be used as an efficient method for damage detection.

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## Analyzing the Implementation of Islamic Design Principles for the Islamic Concept Hospital in Malaysia

### Abstract

Islamic Concept Hospital is a place where healthcare services are provided in accordance with Islamic principles. Malaysia as a multi-racial country with Islam as an official religion has been a pioneer in introducing Shariah compliant products over the last few decades including in healthcare services. Malaysia has become the destination for Muslim medical tourists who prefer treatments and procedures in healthcare centers whereby Islamic practice is applied. Therefore, Islamic Design Principles which promote mercy for all mankind should be considered in the design of Islamic Concept Hospital to promote Islamic awareness, enhance self-esteem, strengthen commitment to Islam and ultimately gain Allah's mercy and forgiveness. Implementation of Islamic principles should not only appear as aesthetic or superficial, but the values shall fulfill the physical needs, the religious and spiritual aspects. Unfortunately, there are no specific guidelines for full implementation of Islamic design principles in Malaysia. Furthermore, there are no studies related to hospital design with implementation of Islamic design principles or guidelines can be found. This paper is to analyze the Islamic design principles that have been implemented in Islamic Concept Hospital in Malaysia by sieving through the opinions of experts from the healthcare industry. This study will utilize the descriptive method rooted in qualitative research. Experts' opinions will be analyzed into thematic analysis by using ATLAS.ti 9 tools. From the interpretation and analysis of the opinions, the results highlight the importance of new Islamic design principles for Islamic Concept Hospital to be outlined, consistent with the qualities in the Islamic Built Environment. The results will hopefully influence the Malaysian administrators and designers to develop a better hospital environment with the implementation of Islamic quality for the benefit of all Malaysians.

### Keywords

Hospital design, Islamic concept hospital, Islamic design principles.

### Biography

Author A. ZAKARIA is currently a PhD candidate in the Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia (UTM). She received her Bachelor of Architecture (2009) and Master of Science, Construction Contract Management (2012) both in UTM. She was working fulltime as a Graduate Architect in Johor Bahru until 2014 and involved in housing, commercial and healthcare projects. Then she moved to the United Kingdom (UK) and now provides service as freelance architect. Her contact information; Mobile no: +6016-7646776 or +447903016352 and email [adilazakaria210@gmail.com](mailto:adilazakaria210@gmail.com)

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## **Social Sustainability Criteria for Urban Transport Terminal in Surabaya**

### **Abstract**

High levels of congestion in urban areas encourage the use of public transportation. Provision of public transportation facilities and infrastructure should be managed appropriately to accommodate community activities. Terminal building as a place to pick up or drop off passengers or freights to reach the final destination has long project life cycle. The existence of building in certain area not only affects the owner and users, but also the surrounding communities. As such, it is very important to accommodate the needs and interests of stakeholders in the building development or construction. The concept of sustainability has been applied in the area of construction management. However, social aspect as one of the sustainability concepts has not received much attention. The concept social sustainability in construction needs to be adopted to provide maximum benefit to the construction projects in both short and long term by accommodating the needs and interests of all stakeholders to achieve the overall project success. This paper is an initial stage of the research to determine social sustainability criteria for urban transport terminal in Surabaya, Indonesia. A preliminary survey involving four experts was conducted to verify several variables that have been identified from the literature. Mean analysis was used to rank the criteria according to the expert's opinion using Semantic Scale from 1 (very Irrelevant) to 5 (very relevant). From 25 attributes, it was found eight variables that are most relevant to measure social sustainability for urban transport terminal as had five (5) means' scores, namely (1) Involve all stakeholders in the decision-making process; (2) Pay attention to health from environmental problems; (3) Pay attention to physical comfort; (4) Easily accessible; (5) Providing equal access without any gender and social status; (6) Providing important amenities; (7) Providing easy travel information; (8) Easy access to passenger movements. This study contributes to the body of knowledge by understanding social sustainability measurement for urban transport terminal building. Keywords: Project success, Social sustainability, Social benefit, Stakeholders, Surabaya, Urban transport terminal

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## Prof. A.K. Shaaban

College of Engineering, Sultan Qaboos University, Muscat, Oman

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## The Impact of Sultan Qaboos University Eco-House on Green Buildings Trends in Oman

### Abstract

The Sultan Qaboos University Eco-House is a prototype research, and design project by Architectural, Civil, Mechanical, and Electrical engineering faculty and students. It was built at the university campus by the University Projects Department. The house achieved the following features: Sustainable location, Sustainable site, Sustainable landscape, Improved site microclimatic, Optimization of thermal properties, Provision of double-shell total system, Maximizing cooling effects by natural ventilation, Use of sustainable building material, Power saving, Total photovoltaic power supply, Water saving, and Grey water treatment.

The Eco-House became a research hub and teaching laboratory for undergraduate and post graduate sustainability courses at the college of engineering. It is also becoming an information center to promote good green building practice. The outreach program included: Internet site, TV interviews, New Papers articles, Public Forums, International exhibitions, Workshops for the engineering profession, Programed visits by students from schools, and universities.



### Keywords

Double-shell, ventilation, landscape, thermal, photovoltaic, power saving

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## Restructuring Information Management in Building Design and Construction Using Metadata

### Abstract

The purpose of this research is restructuring information management in building design and construction process by using accordingly BIM metadata. BIM metadata systems have been appeared in the scene of the architecture and construction chain by addressing multidisciplinary inefficiencies, incapability, disorganization and delaying that have been rooted in the structure of architecture and building chain over decades. However, German and European architecture and construction chains are having huge difficulties in accepting, endorsing and understanding the BIM metadata benefits, as there is no clear guidance and best practices in BIM implementation that can be learned by them as a reliable example. This research aims to represent explain analyze differences between projects that have been designed and built in the traditional way and those who have used accordingly assets of the BIM metadata software. Monitoring, understanding, defining and mapping the problems in particular well-known German Projects that are designed and build in a traditional way are represented in the first phase of the research. This part consists of three projects which I have been researching in different fields, covering the management, process; people, software and technology were investigated through a design and building process. Results in those case studies indicate the current high-Cost and low-Design efficiency, high level of mistake, project building long delays, huge teams involved and no consistency in any of the phases of design and building process. Predominantly attributed to the interoperability of using the 2D cad tools, miscommunication between different team levels, miscommunication in different sections of building chain, and also lack of management developing guidelines and standards that categorized and control the design and building process. The second phase of the research is about, finding out advantages, benefits, assets, differences, and possibilities, from three BIM projects design and built by architecture and engineering offices, where I work as a project leader/consultant based in Germany and Europe. The investigation results show clearly BIM projects benefit of higher accuracy, design quality, team collaboration, and cost and time-efficiency compared to traditional design and build projects. Though indications clearly represent the current low-use and misuse of the BIM software among the teams involved in the building chain. Based on the results, the aim and also the end result of my research will give technical advice, solutions in theory and practice, to shorten the gaps between different operators (architects, engineers, contractors, and others) in the chain of BIM Metadata Structure. This proposal's outcome will give a strong inputs in properly using BIM implementation towards enhancing efficiency and productivity of architecture and building companies, and will strongly open the gate for further proposals in research on understanding and using in advanced level the BIM Metadata in Generative Design, which expresses a relation between Process of Generative Patterns, Parametric Distribution of normative/standards and all operators from industry, engineering, and architecture.



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## **A Real-Time Monitoring of Structural Displacements and Ground Deformation during Construction by Using On-Site Visualization Technique**

### **Abstract**

It is presented herein a monitoring method called “On-site Visualization” (OSV for short)<sup>1</sup> developed in Japan and focused in the monitoring of structures in real-time for fast detection of abnormalities related to variations of deformation and displacements in real-time. In the OSV method the real-time monitored data is converted into colours of light by using the optical fibre as the propagation medium to visualize the variations of both ground and structural deformations; locations of progressive deformation such as cracks, deformations of tunnel linings, ground deformations during excavation, locations of potential slope failure and landslides; strain, inclination, earth pressure, etc. For this purpose a compact data processor with a Light Emitting Converter (LEC) is used to convert the electrical signal of analogue sensors (strain gauges) into variations of colour of light for real-time visualization. A brief explanation of the application of the OSV in some construction projects of tunnels and bridges in Japan and overseas is presented herein. The OSV also includes a method without using electric device to measure and visualize the relative displacement and alignment of structures during construction.

### **Keywords**

On-Site Visualization OSV, deformation, monitoring, LED, sensors, real-time.

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## Using Graph Convolutional Networks to automatically classify elements and spaces in Building Information Models

### Abstract

Building Informational Models (BIM) are increasingly leveraged as a medium for storing, managing and disseminating project information throughout the lifecycle of construction projects. The Industry Foundation Classes (IFC) provide a neutral and open data format to make interoperability possible between multiple applications, making the standard a critical counterpart. Thus, BIM-element to IFC-entity mappings needs to be checked to ensure the semantic integrity of BIM models. Existing studies have demonstrated that 3D deep learning algorithms trained on geometric features are able to classify BIM elements, thereby enabling the checking of these mappings. However, reliance on geometry alone is limited, especially for elements and spaces with similar geometric features. This study investigated the employment of topological relationships between elements and spaces with the assumption that such additions provide higher classification performance. Graph Convolutional Networks (GCN), a novel approach for combining structured graph data as features to deep learning input, was used to realize the experiment. Results demonstrated that a significant improvement was attained when trained and tested on eight BIM element types with their relational semantics explicitly represented.

### Keywords

BIM, IFC, Artificial Intelligence, Deep learning, Graph Convolutional Networks

### Biography

Bonsang Koo is currently a professor at the department of Civil Engineering, Seoul National University of Science and Technology in Seoul, Korea. He previously worked in the U.S. and U.K. as an engineering consultant, as well as a research fellow at CERIK, a think tank for the Korean construction industry.

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His research interests focused on deploying Information Technologies throughout the project management lifecycle. More recently, he has been interested in developing approaches to improve the generation, management and integration of Building Information Models by employing Artificial Intelligence techniques. He is currently the director of the Informatics for Infrastructure Insights (i3) labs.

**Xin Yang\***

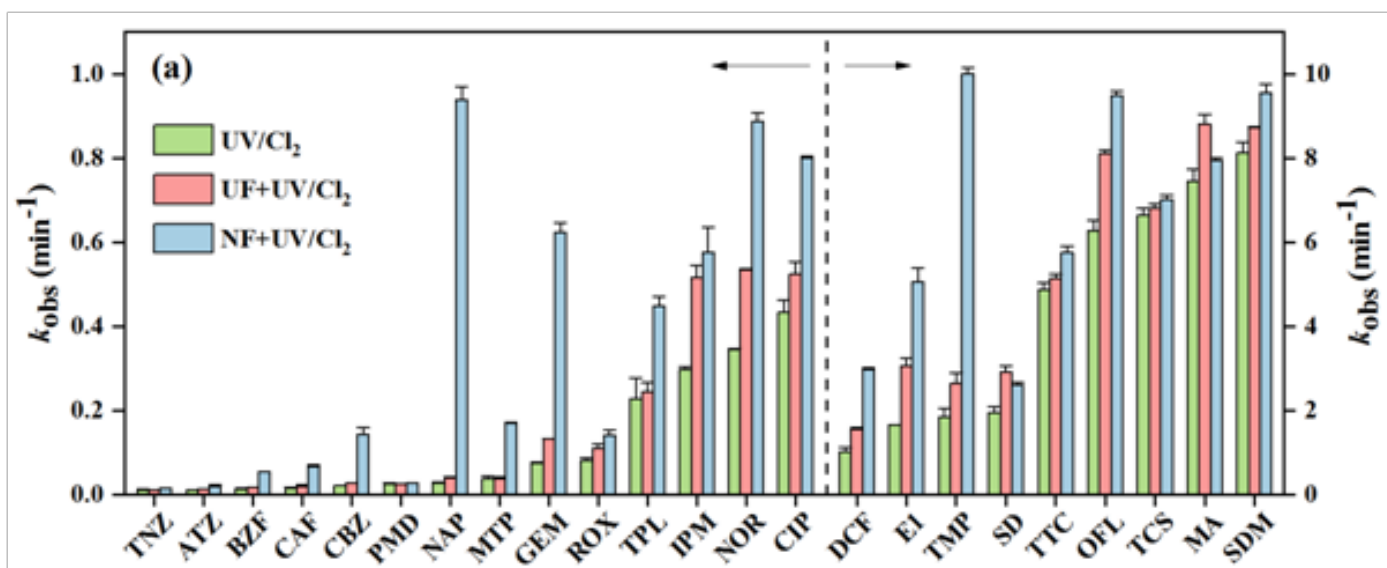
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## PPCPs Degradation and DBP Formation during a Combination of Ultrafiltration/Nanofiltration and UV/Chlorine

### Abstract

The combination of microfiltration and reverse osmosis-UV/H<sub>2</sub>O<sub>2</sub> has emerged the “Gold Standard” to potable water reuse,[1] but chlorine is required to deactivate harmful microorganisms in the treated water.[2] Here, we propose a combination of ultrafiltration (UF)/nanofiltration (NF)-UV/Chlorine process to investigate its efficacy on the removal of pharmaceuticals and personal care products (PPCPs) and the formation potential of disinfection by products (DBPs). The observed decay kinetics of 23 PPCPs under UF-UV/Chlorine process and NF-UV/Chlorine process increased by up to 86% and 3132% compared to UV/Chlorine process. A kinetics model was developed to predict the PPCPs removal in these three processes. The formation potential of DBPs under UF-UV/Chlorine process and NF-UV/Chlorine process decreased by up to 22% and 95% in contrast to UV/Chlorine, especially for trichloromethane. Overall, NF-UV/Chlorine process is a promising alternative for the potable water reuse.



### Keywords

UV/chlorine, micropollutants, disinfection byproducts, membrane filtration

### Reference

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### Biography

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## **Molecular Dynamics Simulation of the Thermal Degradation of Building Polymers for Pyrolysis Kinetics and Gas Decomposition Inputs in CFD Modelling**

### **Abstract**

Currently, the major challenge in solid pyrolysis fire modeling is the lack of fundamental Understanding of the thermal degradation process from solid fuel to gas volatiles. Additionally, the parent gas-phase combustion fuel is difficult to characterize and quantified by means of experimentations [1]. To bridge the knowledge gap, this study proposes a Methodology applying molecular dynamics (MD) simulation as a tool to visualize the thermal degradation process of polymer composites, especially the emission of volatile and toxic gas species. The method was applied to three common engineering polymers: i) polyethene (PE), ii) polymethyl methacrylate (PMMA), and iii) polystyrene (PS). Numerical simulations demonstrated good agreement with the thermo gravimetric analysis (TGA\_ experiments. It was found PE, PMMA, and PS formed fuel gas with alkane group (i.e. mainly C1-C3) that acted as the combustible source. Furthermore, the composition of char formations for the selective polymers are predicted by the MD simulation through analyzing the accumulation of pure carbon chain compounds. In this study, MD simulation identified the detailed decomposition process from solid to gas phases, which the gas decompositions can be used as inputs in computational fluid dynamics (CFD) models [2]. This will significantly enhance the reliability of toxic gas, charring, and smoke particulate predictions.

### **Keywords**

Computational Fluid Dynamics, Fire, Kinetics, Molecular Dynamics, Polymers, Pyrolysis

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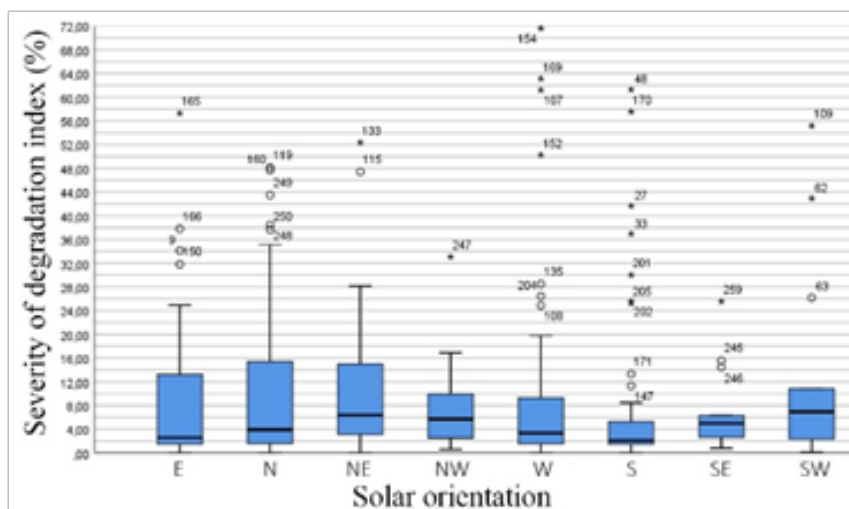
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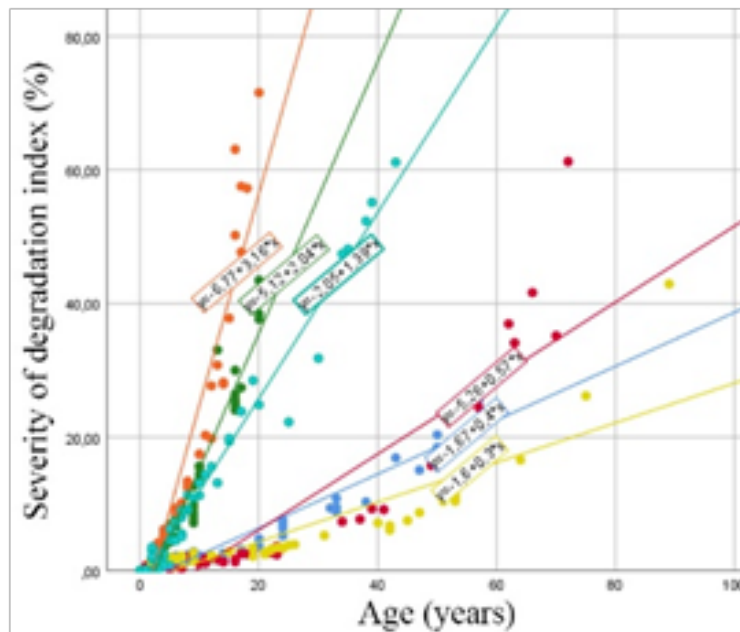
## Impact of Environmental Exposure on the Service Life of Facade Claddings

### Abstract

The facade cladding, as the outer protection layer of the building envelope, is directly exposed to environmental deterioration agents. The context of the façade, defined by solar orientation and proximity to the sea, determines its vulnerability to environmental loads. These loads affect the degradation process of the cladding and the durability of façades. Therefore, studying the impact of the environmental exposure conditions on the service life of different external claddings provides useful information on their performance over time, which can support decision-makers in the selection of the best façade cladding system. This study covers six types of claddings: ceramic tiling systems (CTS), natural stone claddings (NSC), rendered façades (RF), painted surfaces (PS), external thermal insulation composite systems (ETICS) and architectural concrete façades (ACF). 300 façades located in Portugal are analysed according to three main groups of variables, which characterize (i) the facades, (ii) their degradation condition and (iii) the environmental deterioration loads and context. The statistical analysis results (Figures 1 and 2) reveal that the environmental variables affect the cladding degradation process. South oriented façades present lower degradation conditions, than those observed for North orientation. Coastline proximity and high exposure to pollutants contribute to more significant degradation levels. The performance of each cladding is different. Nevertheless, the claddings can be organized according to two main groups: the more durable (CTS, NSC and ACF) and the less durable (RF, PS and ETICS) materials. The most adverse environmental exposure conditions and the less durable materials are associated with higher degradation levels.



**Figure 1** - Box plot of the façades severity of degradation according to solar orientation



**Figure 2** - Scatter plot of the façades severity of degradation and age, according to cladding types, with linear regression

## Biography

Author of 46 scientific publications in indexed journals and of an International Book, entitled "Methodologies for service life prediction of buildings: with a focus on façade claddings. Responsible Investigator of a Research Project and Member of 3 others. Supervision of 4 PhD theses and seven Master theses. Secretary of CIB W080 commission and member of ISO technical committee on Design life of buildings (ISO TC59 SC14).



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## **Towards indoor air-quality forecasting and control using sensor supported computational fluid dynamics**

### **Abstract**

Indoor Air Quality (IAQ) and thermal comfort are fundamental for humans' wellbeing, especially inside buildings, as we spend more than 90% of our time indoors. In the current pandemic situation, the importance of IAQ has been painfully brought into focus<sup>1</sup>. Therefore, it is crucial to control IAQ to provide a comfortable microclimate for occupants and protect humans from health hazards such as airborne infections in hospitals and mitigate exposure during the accidental or deliberate release of contaminants.

Furthermore, transient events such as occupant movement or external environmental change can significantly affect the airflow and contaminant dispersion, such as airborne transmission in hospital rooms or air pollution ingress from outdoors. Computational fluid dynamics (CFD) can predict the dynamic nature of airflow and contaminant transport in great detail and accuracy; however, its usage as a forecasting or control tool is prohibitive due to its long computing times and uncertainty in boundary conditions. Hence our work aims to present an investigation into the development and implementation of a novel sensor supported method for real-time GPU-based CFD approach. This methodology will enable the prediction/forecast of contaminant dispersion due to movement or microclimatic changes, including thermal buoyancy effects, thereby transforming the traditional CFD-based IAQ analysis into a viable tool for indoor environment forecasting, decision support and control.

### **Keywords**

Indoor Air Quality, Computational Fluid Dynamics, Wireless Sensor Network, Data Assimilation

### **Reference**

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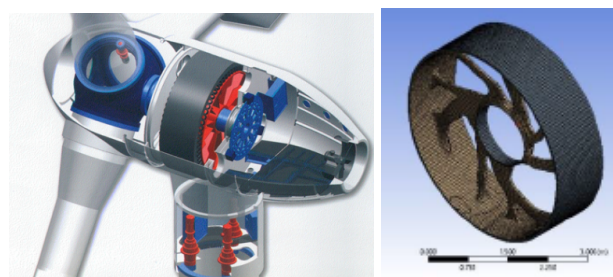
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## An Insight into Structural Design of Wind Turbine Electrical Generators

### Abstract

Minimizing the structural mass of low speed electrical machines for renewable energy purposes is becoming more important as reductions in mass decrease the nacelle capital cost [1]. With direct-drive becoming more dominant offshore and as turbines get bigger, generator structural design becomes more challenging in terms of lifting, manufacturing, material use and replacement. The vast majority of the research in the field focuses all the attention on the mass decrease of electromagnetic 'active material', which includes permanent magnets, copper and back iron. Nevertheless, it is the supporting structure, also known as 'inactive material', which accounts for the highest percentage of mass. Recent advances in computational modelling and structural simulation, including topology optimization and generative design, have helped to come up with more innovative and efficient designs capable of withstanding both static and dynamic loads without compromising air-gap's clearance and stability. Figure 1(a) shows the direct-driven powertrain of a 1.65MW wind turbine. In Figure 1(b), a proposed generator rotor structure modelled using generative design techniques is displayed.



**Figure 1(a)** 1.65MW direct-drive MTorres wind turbine (left); **Figure 1(b)** Generative design model of rotor structure (right)

### Keywords

Wind turbine; electrical generator; structural design; computational modelling

### Reference

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## Predictive and Adaptive Assessment Model of Energy Poverty in Andalusia

### Abstract

Energy Poverty (EP) is defined as the inability to obtain the energy services necessary to achieve thermal comfort in the home, commonly associated with housing inefficiency [1]. Despite the fact that EP is a global problem, accentuated in Europe by the economic crisis, currently no standard has been established to analyse the housing vulnerability of homes, which means that in some countries this type of poverty is not recognised as a social problem [2]. Several studies point out the existence of the EP in Spain, according to the National Institute of Statistics, Andalusia has 37.7% of the population at risk of poverty and/or exclusion (AROPE) at national level (2019) [3]. PE is associated with local conditions, so the model developed is close to the economic, environmental and social reality of Andalusia, in order to predict and evaluate the casuistry of its vulnerable homes. For the analysis of EP, various indicators can be used based on aspects such as expenses, habitability, energy conditions, etc., however, most of these indicators are diagnostic and lack a prediction system. This supports the need to develop the proposed holistic model, adapted to the complex reality of vulnerable homes. For this purpose, the model, in addition to indicators such as the Monetary Poverty Indicator (MPI) that measures the net family income, the Energy Indicator (EI) that allows quantifying the energy consumption and the Comfort Indicator (CI) that measures the hours of thermal comfort, the model integrates indicators such as the "Fuel Poverty Potential Risk Index" (FPPRI) [4] that allow to detect the potential risk of fuel poverty in the housing allocation and the "Index of Vulnerable Homes" (IVH) [5] to diagnose the vulnerability of homes. With these indicators, the model can establish an association between geographical factors, costs, income, consumption, comfort, which allow us to understand the problem as a whole. The developed model allows a comprehensive analysis of EP, from the evaluation of dwellings in the project phase to the vulnerability of inhabited dwellings, considering the climatic adaptability of users and the classification of vulnerable groups in their holistic context, which will allow the generation of sustainable and efficient policies that guarantee minimum habitability conditions.

### Keywords

Energy poverty, vulnerable homes, climate change prediction, climate change adaptation, holistic analysis.

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### Biography

Carlos Rubio-Bellido and Jaime Solís-Guzmán are professors of the Department of Building Construction II at the Universidad de Sevilla. They are principal researchers of the project “Nuevo Análisis Integral de la Pobreza Energética en Andalucía (NAIPE). Predicción, evaluación y adaptación al cambio climático de hogares vulnerables desde una perspectiva económica, ambiental y social (US-125546)” funded by the European Regional Development Fund (ERDF) and by the “Consejería de Economía y Conocimiento de la Junta de Andalucía (Spain)”

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## The Bridges of Architecture

### Abstract

The 1949 exhibition at MoMA The Architecture of Bridges curated by Elizabeth Mock inaugurated a fresh view to the field of collaboration between engineers and architects. Among other reasons, the appearance of new technologies and materials as steel in XIXth century and concrete in XXth provoked a gap that the architects of modern movement detected without really solving the distance between the beauty of honesty and the intellectual swindle of certain architectures. Second half of last century deployed technology for massive reconstruction and exponential urban growth and therefore a context of obliged reunion of the two disciplines. The MoMA's exhibition followed by others in Pompidou center illustrated the new collaboration between engineers and architects, from Utzon and Arup to Ishigami and Sato, from the mechanical to the green paradigm. This paper aims to analyze those contributions in both directions through an analysis of the history of the construction of bridges. First putting an eye to their architecture where we will describe the most relevant examples designed by architects, from Palladio to Plecnick. Secondly, by a prospection to the technology transfer that silently by with no interruption has taken place from the construction of bridges to edification with brilliant examples from Freyssinet to Viereck. Both views, with central examples as Peter Rice or Jean Prouvé, show how those collaborations go beyond the specific to build an intermediate field that today is central for a balanced sustainable development.

### Keywords

Bridges, Architecture, structure, collaboration

### Reference

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- 2] E. Mock, The Architecture of Bridges. New York: The Museum of Modern Art, 1949
- [3] P. Rice, An engineer imagines. London: Artemis, 1994

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## **Sustainable Recovery of Abandoned Buildings: CO.DE.WA.R. Method for Low-Carbon Refurbishment Interventions**

### **Abstract**

The progressive abandonment of inner areas has led, in many countries, to the promotion of relocation policies to encourage the repopulation of these places. In this direction, some Administrations are taking action to enhance the patrimonial and peculiar character of these abandoned areas, through strategies to strengthen communications and services, aimed at promoting their development and attracting new inhabitants. The strategy of repopulation requires the recovery and re-functionalization of abandoned buildings, to be used as new key functions for the recovery of social and economic development of the territory. The renovation of buildings generates a volume of construction and demolition waste (CDW) that will have to be properly managed in accordance with the guidelines of European directives aimed at achieving a circular economy. To this end, knowledge of the type of CDW generated and its possibilities of use is the first step to contribute to this goal, operating in the process of environmental protection. The aim of the research consists in the elaboration of a model (CO.DE.WA.R: Construction & Demolition Waste Reduction) aimed at minimizing mixed undifferentiated waste, to be landfilled, in the rehabilitation interventions of this building heritage. The project proposal of the case study includes the analysis of the waste generated and its possible reuse in the building itself or in the construction market. This "from grave to cradle" method allows to obtain, in addition to the reduction of waste from demolition operations, also a lower exploitation of virgin raw materials for the construction of the new building.

### **Keywords**

low-carbon buildings, sustainable buildings refurbishment, waste reduction, low-carbon Life Cycle, reuse, recycle

### **Reference**

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## Hydro-geomorphologic application in headwater catchments (Southern Italy)

### Abstract

Since 2010, three catchments, located in the southern Campania region, have been studied using an interdisciplinary approach—geomorphological, hydrogeological, and hydrological—and a hydro-chemical monitoring system. These Mediterranean catchments have been modelled at event time-scales by using the HEC-HMS model, adopting object-based hydro-geomorphological class features. For calibrating the hydrologic parameters, the event scale analysis was performed on hydrographs recorded at the outlet of the catchments. The physical-based rainfall–runoff modeling was then conducted using different procedures to optimize the catchment modelling: (1) applying the recession coefficients to each outlet with a newly defined hydro-geomorphologic index (HGml); (2) assessing the storage coefficient for each sub-basin as a weighted mean of HGml; and (3) using the storage coefficient associated with the largest HGml in the sub-basin. The adopted procedures were tested using diverse goodness-of-fit indices, resulting in good performance when the object-based hydro-geomorphotypes were used for the parameter calibration. The adopted procedure can thus contribute to improvements in rainfall–runoff and water budget modeling in similar ungauged catchments in Mediterranean, hilly, and forested landscapes.

### Keywords

Hydro-geomorphology, water balance, HEC-HMS

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## Restructuring the Circular Economy into the Resource Balanced Economy

### Abstract

The proposed Resource Balanced Economy is an evolution of the Resource Based Economy, with the integration of exergy as a limit derived decision tool. All resources are defined as existing valuable commodities subject to mining, and the waste side stream secondary resources. This includes the use of a thermodynamical exergy term as a limiting metric to produce a practical system.

An evolution of how raw materials are characterized is recommended. A unified characterization protocol, capable of mapping samples from all parts of the value chain (from mineralized ore to recycled waste) for each mineral/metal/material is proposed.

A series of system maps are proposed to be developed, tracking the industrial steps in transforming a natural raw material (for example mineralized ore) into a refined chemical or pure metal to the manufacture of a technological unit (like a computer or wind turbine). This system has the potential to manage more effectively technology and its supporting resources in a low energy future. It is hoped that this system could address some of the wealth inequalities in current society.

### Keywords

Circular Economy, Resource Balanced Economy, Resource Based Economy, Mining, Recycling, Waste, Exploration, Energy, Exergy, Entropy, 4th Industrial Revolution, Artificial Intelligence, Machine Learning, Block Chain

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Aristotle University of Thessaloniki, University Campus, Greece

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## **Development of a Model for the Selection and Use of Industrial By-Products in Environment- Friendly Constructions**

### **Abstract**

Sustainable solutions in construction seem to be more and more imperative after the catastrophic phenomena due to climate change. The construction sector is essential for world economy and is charged with the depletion of natural resources and burdening the environment with emissions. Industrial by-products are produced locally and can be ashes (from coal combustion or biomass burning), slags, recycled concrete aggregates, recycled tires or glass aggregates.

In parallel to green energy efforts, it is of vital importance to adopt environmentally friendly solutions in construction and particularly in infrastructures, where large quantities of materials are absorbed (road pavements, dams, bridges, tunnels).

However, the first step to implement sustainability in construction is to provide contractors with data concerning the alternatives to conventional materials, such as availability, transportation, cost, benefits related to performance and durability, relevant regulative frames, technical instructions for application and a proven estimation of the low environmental profile.

By exploiting experience from research and practice, it is feasible to find applications of by-products which are not only environmentally friendly but also cost effective and beneficial for quality and service life of the project.

Digital tools such as Life Cycle Assessment (LCA) and Life Cycle Cost Analysis (LCCA) can be used, taking into account the desirable service life of each infrastructure.

The cornerstone for the development of a model that decides which by-products and how they could be used, is the creation of a dynamic, realistic platform, including data referring to local climatic conditions, logistics, technoeconomic status and social sensitivity to sustainability, apart from the characteristics and performance of the by-products themselves as building materials.

The paper focuses on the necessary data which should be properly uploaded and how they could be used, so as the development of a model can be feasible, leading to reliable and sustainable solutions.

Electronic register of local by-products is very helpful for providing information about health related issues such as REACH approval or other requirements.

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The benefits of employing a model for the selection and use of by-products in infrastructures are documented with examples from real projects.

### **Keywords**

industrial by-products, infrastructures, sustainability, life cycle assessment

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## Advanced Satellite Remote Sensing for Urbanization Analysis

### Abstract

This research presents the advanced satellite remote sensing missions and methodology for data collection for detection and analysis of the urbanization, urban growth pattern as well as environment change. The research presents a methodology for determining the optimal satellite missions for the purpose of environmental change detection and urbanization monitoring. The research deals with the novel state-of-the-art methods for satellite imagery preprocessing, classification as well as automatic land-cover maps generation. Furthermore, the accuracy assessment measures of the land-cover classification will be discussed. The entire process of growth pattern detection and urbanization, as well as environment change analysis, will be shown in real case studies. Presented methods and techniques were based on the machine learning approach and novel automatization workflows and methodologies. The change detection analysis was made by comparing the land-cover maps made based on the 30 m bands of Landsat satellite imagery. For all cases, open-source data and open-source software were exclusively used to conduct this research. Therefore, presented procedures, techniques, and knowledge can be easily used, free of charge in the environment change detection as well as urbanization analysis for other areas in the world.

### Keywords

remote sensing; urbanization; classification; Landsat; automatization

### Reference

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## **The Relationship between Traditional Leaders, Municipal Spatial Planning, and Land Use Management: The Case of Polokwane Municipality, Limpopo**

### **Abstract**

The purpose of this study is to examine the relationship between traditional leaders, municipal spatial planning and land use management in the Polokwane local municipality located in the Limpopo province of South Africa. This examination is premised on the assertion of the existing urban and rural division / segregation, land tenure security crisis, lack of sense of place, and the poor housing strategies in former disadvantaged areas often referred to as communal land. Municipal spatial planning and land use management in South Africa has not been comprehensive before; thus, failing to be inclusive and disadvantaged local municipalities efforts. As a result, not much scholarly research has been conducted pertinent to communal land areas in the South African context. Conclusively, the provision of housing has to look beyond the mere delivery of a house; and instead, incorporate values / norms, cultures and the vision of sustainable human settlements as envisioned by the Breaking New Ground Policy. Our research approach is a qualitative research method. The use of both primary and secondary methods of data collection such as the use of questionnaires, key interviews, key informants, observations, journals, books, articles, and supporting documents are also employed. The results indicate a lack of understanding from community members and limited involvement of traditional leaders with reference to spatial planning and land use management in the Municipality. Aligned with this challenge, it was recommended that service provision can be improved through the upgrading of land tenure system previously neglected and the completion of outstanding planning milestones as set out in the new Spatial Planning Land Use Act of 2013.

### **Keywords**

Spatial planning and land use management; housing provision; tribal planning and traditional leadership.



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## **Modelling Sediment Load Using Sediment Rating Curves In Lutanadwa River Catchment, Limpopo, South Africa**

### **Abstract**

Sediment load prediction is important in planning and design of engineering hydraulic structures especially dams whose reservoir capacity and life is dependent on the sedimentation rate. Sediment load information is also important in calibration of hydrological models used for sediment yield prediction. The purpose of this study was to establish the relationship between sediment concentration and discharge for sediment load prediction. Depth integrated samples were collected from a selected river section on various dates in the Lutanadwa river catchment, Limpopo, South Africa, and analyzed for suspended sediment concentration. Corresponding discharge was computed from stage measurements taken at a nearby gauging station downstream of the sampling location. The measurements were taken across various seasons being winter, spring, summer and autumn. The sediment rating curves were generated for every season based on the log-log regression relating sediment concentration and discharge and based on the graphical plot of log transformations of concentration (mg/l) and discharge (m<sup>3</sup>/s). Estimated sediment load based on the prediction from seasonally varying rating curves was compared to the SWAT model predicted sediment load. A satisfactory relationship was obtained between observed and predicted sediment concentration predicted using developed sediment rating curves. Performance measures used included Coefficient of determination (R<sup>2</sup>), Percentage Bias (PBIAS) and Nash Sutcliffe efficiency (NSE). The best regression relationship between sediment concentration and discharge varied from season to season. The developed rating curves show promise for use in model predictions for sediment load modelling.

### **Keywords**

Rating curves, Sediment load modelling, prediction performance evaluation.

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### Biography

Dr. John P.O Obiero holds a B.Sc. M.Sc. and PhD in Agricultural Engineering. He has over 20 years of experience in university teaching, research, consultancy and community service in various universities in Kenya including South Africa. He has authored or co-authored over 20 publications in refereed journals and book chapters, has presented scientific papers in many local and international conferences. He has undertaken consultancy assignments in water supply and irrigation, coordinated donor funded collaboration projects, implemented funded research projects as project leader and principal investigator, has undertaken a number of administrative responsibilities including severally being appointment Acting Chairman of engineering department and Head of a department, served in committees including curricula development, postgraduate studies, research, has been engaged in community-based projects involving water supply, sanitation and climate smart agriculture, served as member and official of professional organizations, Supervised to completion undergraduate and post graduate students design and research projects.

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## Innovation Through Convention: A Renaissance for Precast Concrete

### Abstract

This paper presents a research and design project that demonstrates how creative application of conventional prestressed precast concrete elements can lead to architectural innovation in building integration. The project research identified the inherent virtues and optimized sizing of these elements for structure and enclosure, while revealing the potential for their deployment in multiple modes of integration. The architectural design outcomes demonstrate a novel approach to systems integration and a 21st Century realization of the Vitruvian triad of commodity, firmness and delight through twelve building types and thirty-six variants.

The mass standardization of conventional precast elements in the United States has found practical application primarily in parking garages, industrial and warehouse buildings. As an unintended consequence, the use of precast concrete has become primarily associated with economy and efficiency in pragmatic building types often exhibiting minimal integration or aesthetic value. As a result, contemporary architects are often inhibited from recognizing the virtues and latent creative opportunities for utilizing conventional precast elements in elegant and novel ways, and to design a broad range of building types with precast concrete.

To address this deficiency, two distinct research methods were employed. In-person interviews were conducted with the owners and engineers of a large regional precast industry producer, using structured and open-ended questions. The interviews identified quantitative criteria used in precast element design and production to maximize cost-to-benefit ratios, including structural size-to-span ratios and building uses, heights and floor area. These criteria established pragmatic quantitative parameters for design. Qualitative research was conducted through examination of the theory and design principles established by the Living Building Challenge and the AIA COTE Framework for Design Excellence. Using literary analysis and case studies, five content areas were identified, evaluated and synthesized as most appropriate to address through the use of precast concrete elements. These included design principles for holistic integration, material, economy, adaptability, and beauty.

To demonstrate the application of the research findings, design experiments using digital simulation, modeling, and 3-D printing were conducted to activate the parameters and principles, with a primary objective to realize holistic integration. The precast elements were integrated with multiple modes of daylighting, shadow generation, adaptable space matrices, and clear expression of structural load paths. The success of the design outcomes was evaluated in relationship to the quantitative and qualitative research benchmarks. The thirty-six variant building designs demonstrate integrative innovation in a construction material type that typically exhibits uncreative solutions and limited

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integration. The project speculates on a new era for precast concrete, a renaissance for the industry and for architects.

### **Keywords**

precast concrete, architectural integration

The project was funded by a Lawrence Technological University blind peer-review grant.

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## Performance of Bridges in the U.S. State of Georgia: Analysis of 25-year NBI Inspection Records

### Abstract

Sound bridge asset management requires long-term planning due to the anticipated long service life of bridges. Crucial to this management practice is the assessment and analysis of bridge performance indices for decision making at project and system levels. This study analyzes the performance of bridges in the U.S. state of Georgia based on the historical NBI bridge data. Multi-decision criteria such as the year of construction, structure type, structure length, and average daily traffic were analyzed and related to the overall bridge performance. Due to the complexity of the data, codes were developed for the analysis which interacts effectively with the bridge inspection records in NBI ASCII files. These analyses include trends in the performance of the bridges for a period of 25-year. Bridge data retrieved from NBI database were divided into five age bins – <1900, 1900-1930, 1930-1960, 1960-1990, >1990 periods, respectively. The analyses compare the performance of bridges based on the sufficiency ratings (SR), as a function of age and other selected criteria. They provide a systematic approach, and yet simple, or at least first step, for different transportation agencies, including State DOTs and FHWA, to track the historical performance of bridges; develop appropriate models and performance measures for an effective bridge MR&R and preservation as public equity.

### Keywords

Bridge asset management; Decision making; Multi-decision criteria; Performance measure; Service life, Sufficiency rating.

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## Inductance-Based Charging Infrastructure Planning for Electric Vehicles Under Zonal Power Constraints

### Abstract

Automobile emission is a major challenge around the globe. In USA, the transportation sector is responsible for 29% of the total emission. Battery Electric Vehicles (BEVs) powered by greener sources like solar, hydro and wind power have the potential for alleviating the current state of emission. Despite the recent advancement in technology, BEV pose several drawbacks including recharging time, limited range, and inadequate number of charging facilities. In an effort to address these drawbacks, inductance-based charging is gaining attention. It allows charging vehicles while in motion often termed as dynamic wireless charging (DWC). It can be implemented by embedding the induction coil under a roadway pavement to dynamically charge the BEV in motion without a need to stop. This prompts an important question for planning the infrastructure for the future of BEV: how to optimally locate DWC infrastructure in a road network. Planning optimal DWC plan, needs to consider how BEV drivers will react to the newly implemented DWC facility in terms of route choice to reflect their unilateral utility minimization objective. Further complexities of DWC implementation include availability of zonal surplus electricity. In this study, we propose a bi-level planning approach considering both the objectives of the planners and the BEV drivers. The approach explicitly incorporates five elements: system-level social costs, travel patterns of individuals, trip completion assurance, zonal DWC implementation constraint due to energy availability from grid, and total budget availability from the public agency.

### Keywords

Battery electric vehicle; dynamic wireless charging; range constraint



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## Bridge Load Testing and Evaluation Using Digital Technologies

### Abstract

Digital image analysis techniques and advanced algorithms have been used to perform load testing of bridges in a more efficient, non-contact manner to measure deformations. Bridge load testing has typically involved deploying multiple, discrete strain sensors that are mounted to a bridge to capture strains as a known load crosses the bridge. In this study, two cameras and VideoGauge™ software are used to capture deformations of a simply-supported, composite steel bridge during a controlled load test with multiple truck loading scenarios. The digital measurements are compared to deformations captured by string potentiometers (displacements) and strain transducers that are mounted to the bridge at midspan of each girder as well as at the quarter span and ends of select girders. Using both the digital image measurements and sensor data, the lateral live load distribution is computed and compared to AASHTO live load distribution factors. Using the bridge plans and data collected, a finite element bridge model is generated, calibrated, and used to conduct a bridge load rating per the AASHTO LRFR method. Based on the findings, a procedure to evaluate bridges using digital image measurements is proposed.

### Keywords

digital image measurements, load testing, bridge evaluation

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## Seismic Performance of Reinforced Concrete Shear Wall Buildings

### Abstract

This article presents a study on the seismic performance of reinforced concrete shear wall buildings with focus on shear strength of walls that are designed using the seismic design provisions of the National Building Code of Canada. A set of buildings, four, six and eight storey's with a simple configuration and different heights have been considered here. While the static and linear dynamic analyses indicate the robustness in the design but dynamic time history analysis indicates deficiency in the shear capacity in the plastic hinge region. It is observed that a dynamic amplification factor for shear on flexural walls governs the shear demand. Here, a simple method has been proposed to estimate the amplified shear demand and to enhance shear resistance of a structural wall economically to avoid unintended shear failure.

### Keywords

Reinforced concrete, Shear wall, Seismic demand, Dynamic analysis.

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## Road Design Using Alternative Data Sources

### Abstract

For relocating existing infrastructure facilities and designing new infrastructure with final design plans, we need accurate surface terrain information. At present traditional surveying and photogrammetric mapping are the common methods in use due to their high accuracy. However, both methods are time-consuming and resource intensive. It would be beneficial to find alternative methods for collecting accurate surface terrain information. Light Detection and Ranging (Lidar) data collected using airplanes, mobile terrestrial vehicles, or unmanned aerial vehicles (UAV) may provide an alternative technology to obtain terrain information. Various research show that the accuracy of Lidar data is adequate for many applications. However, the suitability of Lidar data in road design has not been explored sufficiently. The research reported in this paper attempts to fill that gap. The lidar point cloud data used in this research was obtained from the Idaho Transportation Department (ITD) in a LAS file format. Since the objective of this research was to assess the suitability of terrain models created using lidar data, we processed the LAS files using software used by transportation departments in the US. Since OpenRoads Designer from the Bentley Company is the predominant software used for road design, we used this software to process the point cloud data in the research reported here. For comparative analysis ArcGIS was also used to process the data. ITD also provided us with elevation data collected using traditional topographic surveying for selected points in the survey area. The data set obtained from traditional surveying were used as ground truth and root mean square errors (RMSE) for the three remotely collected datasets were calculated. Statistical analysis was also performed to compare the four sets of elevations. Cost Comparison was also done to find out the effectiveness of the alternatives.

### Keywords

Road Design, Lidar, UAV, ArcGIS, Terrain Models

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## **Application of High-performance Computing and Machine Learning in the Prediction of Sound Diffusion Coefficient**

### **Abstract**

Over the past couple of years, high-performance computing and machine learning has been successfully applied to several areas in acoustics including impulse response analysis, signal processing problems such as speech synthesis, source localization, and blind estimation of room acoustic parameters from reverberated speech, and structural vibration. It has also been applied to the acoustic of small outdoor environments. In this research we propose the use of high-performance computing powers and machine learning algorithms for acoustic evaluation of sound diffusers which proposes a complex challenge. It requires the efforts to try different machine learning algorithms to find the best fit model to learn the mapping from a large class of shapes (diffuser's geometry), Modulation, and periodicity of the diffusers to the resulting frequency- and angle-dependent polar acoustic pressure levels in time domain.

### **Keywords**

Architectural Acoustics, Sound Diffusion Coefficient, High-performance Computing, Machine Learning

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## Numerical Simulations for the Extraction of Wave Energy along the Coast of Ensenada, Baja California, Mexico

### Abstract

The inversion in marine energy, combined with other renewable energy sources, can help reduce environmental problems, as well as overcome and compensate for the progressive reduction of fossil fuels. In recent years Mexico was committed to reducing the consumption of fossil fuels. Hernández-Fontes et al. (2019) provide a theoretical estimation of available power from waves along the coast of Mexico, founding the greatest availability in the Pacific Ocean. The authors underline that specific studies aimed at the extractable energy potential near the coast of Mexico, are still missing. A methodology for a first-level assessment of expected efficiency of wave-power plant along the coast of Ensenada, based on typical meteorological conditions is proposed. Wave-generation simulations are performed with the SWAN+ADCIRC model (Dietrich et al., 2012). In order to grasp the variability of meteorological conditions, the Typical Meteorological Year (TMY) is identified on the basis of the Finkelstein and Schafer (1971) method. Simulation results for wave heights and peak periods are used to calculate wave power at a distance of about 100 km from the coast. Results show that wave energy potential along the coast of Ensenada is of the order of 5-10 kW/m, constant throughout most of the year.

### Keywords

Wave Energy, SWAN+ADCIRC model, Ensenada, Mexico

### Reference

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## **Firm Identity and Image: Strategic Intent to Act Sustainably and the Opportunistic Antecedents to Sustainability Reporting**

### **Abstract**

We study a firm's likelihood and level of engaging in sustainability-oriented activities and the extent to which the range of those activities is influenced by how they engage with stakeholders through their vision, mission and values statements. We find that sustainability reporting by the sample companies is a sustainability communications strategy for those firms whose business strategy is likely to be more influenced by external stakeholders than internal stakeholders. When simply reporting on sustainability, there is a slightly greater emphasis on communicating more with external than internal stakeholders among the firms sampled. Our second dependent variable examined the level of sustainability reporting by firms or the total number of sustainability initiatives that they are engaged in. A firm's level of sustainability reporting is influenced more by including external stakeholders in their strategic messaging, than it is by including internal stakeholders.



# **Poster Presentation**

## **Day- 4**



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## Bridge Carbon Emission Based on Fuzzy Mathematics and Grey Correlation Research and Driving Factor Analysis and Optimization

### Abstract

In view of the rapid growth of global environmental contribution of the construction industry and the pollution of bridge structures, governments, and scientific research all over the world have paid attention to it. The endogenous characteristics of the construction industry cross industry, cross field, cross region, long production and operation cycle, large number of materials, etc., are the barriers to reduce the environmental contribution of the construction industry. In this paper, cast-in-place single tower cable-stayed bridge and fabricated arch bridge are selected as research cases, and scientific research methods such as multi-level fuzzy mathematics evaluation, middle end point data modeling analysis, flow chart comparative optimization and grey correlation analysis are applied to obtain bridge optimization decision-making method. More than 36860 sets of data impact analysis were completed in the study. The data showed that GWP contributed the largest amount of 400604.48 tons and 347820.96 tons, accounting for 98.5% and 98.2% of the total amount. Material manufacturing accounted for 67.4% and 68.3% of the total. Transportation has emitted a lot of greenhouse gases, generating 4604.3 tons and 5959.7 tons. The future trend of reducing carbon contribution of construction industry is to select renewable materials, research and develop low-carbon fuels, fine production, mechanical intelligent construction, big data optimization analysis and other measures.

### Keywords

Environmental contribution; LCA research; fuzzy mathematics; data modeling; impact factor



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