

# Book of Abstracts



*4<sup>th</sup> Symposium on Civil Engineering  
and Spatial Planning*

# **Book of Abstracts**

of

## **4<sup>th</sup> Symposium on Civil Engineering and Spatial Planning**

**Editors:**

Humberto Varum, Álvaro Costa, João Poças Martins,  
Daniel Clemente, João Pedro Martins, Paulo Jorge Soares

Porto  
June 2021

This volume contains the abstracts presented at the Symposium on Civil Engineering and Spatial Planning, within the 4<sup>th</sup> Doctoral Congress in Engineering – DCE21, held online, between June 28<sup>th</sup> and 29<sup>th</sup>, 2021.

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**Edited by:** Humberto Varum, Álvaro Costa, João Poças Martins, Daniel Clemente, João Pedro Martins, Paulo Jorge Soares

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# WELCOME

We want to warmly welcome all participants to the Symposium on Civil Engineering and Spatial Planning (SCESP), held in the scope of the 4<sup>th</sup> Doctoral Congress (DCE21) hosted at the Faculty of Engineering of the University of Porto (FEUP), Porto, Portugal, on the 28<sup>th</sup> and 29<sup>th</sup> of June 2021. This time, due to the COVID-19 pandemic, the event is entirely conducted in virtual mode. This Symposium is organized by PhD students of the Doctoral Program in Civil Engineering (PRODEC) and Doctoral Program in Spatial Planning (PDPT) at FEUP, with the support of the professors.

The Civil Engineering and Spatial Planning Symposium covers broad, important and multidisciplinary themes, with oral and poster presentations comprising a wide range of topics such as building construction, geotechnics, hydraulics, materials and construction, spatial planning, structures, transport infrastructures, transport planning and territory, and any related multidisciplinary or transversal areas of study.

It is with great honour that we welcome the Keynote Speakers, who elevate the Symposium with their participation:

- Dr. João Pita, Head of Airline Business at the São Paulo International Airport/Guarulhos;
- Eng. Tiago Braga, CEO of Metro do Porto;
- Dr. Tiago Ferradosa, doctorate researcher at Faculty of Engineering of University of Porto and researcher at CIIMAR.

The Organizing Committee received over 54 communications. A total of 39 oral and 15 poster presentations of great quality were selected.

We take this opportunity also to acknowledge all authors for their contributions, the Scientific Committee and the participant Institutions for their support.

Thank you all!!

Porto, June 2021

**Symposium Organizing Committee**

## **Message from the Symposium chairs**

Although Civil Engineering and Spatial Planning research is increasingly specialised, forums that promote discussions across research fields are critical towards the development of original work. Therefore, following the previous editions, the 4th Doctoral Congress in Engineering's Symposium on Civil Engineering and Spatial Planning encourages the participation of current and prospective doctoral students from different institutions. The Symposium has become a relevant event for researchers who wish to disseminate the results of their work and for those at the early stages of their research alike, and is thus strongly supported by the Civil Engineering and Spatial Planning Doctoral Programmes.

Over 50 contributions, including oral presentations and posters will be presented during two days, covering topics such as Material and Digital advances, Transports and Spatial Planning, or Developments on Seismics, Hydraulics and Urban Forms. The Symposium will also include workshops and round tables with industry partners.

Special thanks are due to the PhD candidates who compose the Organising Committee and to the members of the Scientific Committee who have carefully reviewed the papers that are included in the conference proceedings.

Porto, June 2021

**Humberto Varum**

**Álvaro Costa**

**João Poças Martins**



## Scientific Committee

**Chair:** Humberto Varum | FEUP

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João Pedro Martins | PhD candidate in Spatial Planning, FEUP

Daniel Clemente | PhD candidate in Civil Engineering, FEUP

# PROGRAMME

		SYMPOSIUM ON CIVIL ENGINEERING & SPATIAL PLANNING	
		28th June	29th June
8:30	9:00	Welcoming, rules	Welcoming, rules
9:00	9:30	Welcome Session	Keynote Speaker: Tiago Ferradosa
9:30	10:00	Keynote Lecture	Technical Session III: Developments on Seismics, Hydraulics and Urban Forms
10:00	10:30	Keynote Speaker: João Pita	
10:30	11:00	Technical Session I: Material and Digital advancements	
11:00	11:30		
11:30	12:00		
12:00	12:30		
12:30	13:00		
13:00	13:30	Lunch + Workshops	Lunch + Workshops
13:30	14:00		
14:00	14:30		
14:30	15:00		
15:00	15:30	Poster Session	Round table: ‘Early Stage Research with Industry’
15:30	16:00		
16:00	16:30	Keynote Speaker: Tiago Braga	Awards Ceremony
16:30	17:00	Technical Session II: Transports and Spatial Planning	
17:00	17:30		
17:30	18:00		Closing Session
18:00	18:45	Social Program	



## Keynote I - Doutor João Pita (28<sup>th</sup> June, 10:00h-10:20h)

**Topic:** *I have a PhD and now what? A market perspective.*

## Technical Session I - (28<sup>th</sup> June, 10:20h-13:00h)

### **Topic: Material and Digital advancements - Moderated by Paulo Soares**

- Filipe Almeida, Ana Fernández-Jiménez, Castorina S. Vieira, Nuno Cristelo and Maria de Lurdes Lopes. *Mechanical behaviour of mortars including a hybrid cement and recycled aggregates*. [177];
- Nara M.O. Cangussu, Leandro M. Silva, Stéphanie O.N. Rocha and Lino Maia. *Incorporation of the Sludge of Sewage Treatment Plant on Ceramic Bricks Manufacture* [3];
- João Teixeira, Cecília Schaefer, Lino Maia, Bárbara Rangel, Jorge Lino and Rui Neto. *Workability control in the development of 3D printing cementitious mortars - laboratory methodology* [158];
- João Lázaro, Matheus Pereira, Pedro Alves Costa, Luís Godinho. *Performance of low height railway noise barriers* [187];
- Nelson Traquinho, Rui Artur Bártolo Calçada and Diogo Rodrigo Ribeiro. *Influence of Rail Damages on Dynamic Responses of Steel Railway Bridges under Vehicle Loading-A Review* [298];
- Ahmed M. K. Abouelmaty, A. Colaço and P. Alves Costa. *Vibrations induced by impact pile driving: experimental and numerical analysis* [212];
- Rui Valente, Mário Pimentel and Sandra Nunes. *Tensile response of reinforced UHPFRC elements*. [104];
- Luis Sanhudo, João Poças Martins and Nuno Ramos. *Artificial Intelligence for an Enhanced As-Is BIM Energy Analysis*. [144];
- Mohamed Nour El-Din Abu Shamma, João Poças Martins and Nuno Ramos. *Digital Twins for Buildings Energy Management and IEQ within BIM Standard Specifications*. [145];
- Adeeb Sidani, João Poças Martins and Alfredo Soeiro. *BIM For Safety a General Framework*. [292];
- Mohammad Darabseh and João Poças Martins. *Exploring the Blockchain Adoption Directions in the AECO Industry*. [305];
- Mahmoud Karaz and Jose Manuel Cardoso Texiera. *Developing a Construction Supply Chain System based on Lean Construction and Building Information Modelling supported Internet of Things standards*. [368].
- Fábio Matoseiro Dinis, João Poças Martins, Bárbara Rangel and Ana Sofia Guimarães. *Framework for the semantic enrichment of BIM models through a natural user interface*. [130].

**Poster Session I - (28<sup>th</sup> June, 15:00h-16:00h) - Moderated by Isabel Coimbra**

**Virtual Session:** <https://paginas.fe.up.pt/~dce/2021/programme/poster-session/>

- Nara M.O. Cangussu, Pollyana L. Ramos, Tulio A.D. Tolentino, Stéphanie O.N. Rocha and Lino Maia. *Concrete with coarse aggregates partially replaced by recycled construction and demolition waste*. [4]
- Sayedreza Jafarzadeh and Cyrus Eshaghi. *Investigating the Retaining Wall Stiffness Relative to the Stiffness of Surrounding Soil in Order to Find the Exact Position of Base Level of Buildings*. [16]
- Ana Thereza Carvalho, Daniel B. C. Machado, Lino Maia and José Santos. *Advantages of use of BIM methodology in civil construction*. [23]
- Ana Thereza Carvalho, Lino Maia and José Santos. *BIM as a tool for Facility Management*. [24]
- Ana Cláudia Proença, Cecília Silva and José Palma-Oliveira. *Designing Cities for Sustainable Mobility Mindsets*. [28]
- Filipe Figueiredo, Eriton Botero and Lino Maia. *Treatment of cassava starch bagasse for use as pozzolan in cementitious materials*. [32]
- Daniel B. C. Machado, Ana Thereza Carvalho, Lino Maia and José Santos. *Uses and benefits of BIM in construction management*. [34]
- Daniel B. C. Machado, Stéphanie Rocha, Alvaro Junior, José Santos and Lino Maia. *Characterization Of Concrete Blocks Commercialized In The City Of Montes Claros - MG*. [35]
- Anas Shrefahe. *City Archive: A tool for raising a city from the ashes. The case of Aleppo, Syria*. [136]
- João Teixeira, Rui Neto, Cecília Schaefer, Jorge Lino, Bárbara Rangel, Lino Maia and Sandra Nunes. *Development of an extruder for laboratory testing of 3D printing mortars*. [157]
- Gonçalo Ferreira, Pedro Aires Montenegro, António Henriques and Rui Calçada. *A probabilistic view on high speed low cost railway bridges*. [186]
- Stéphanie Oliveira Nina Rocha, Jessé Lima, Pedro Quintino, Daniel Bc Machado and Lino Maia. *Evaluation of concrete pavers using plastic as fine aggregate*. [190]
- Stéphanie Oliveira Nina Rocha, Ises da Silva, Izael Junior and Lino Maia. *Partial replacement of Portland cement for by-product waste silica in cored concrete blocks* [193]
- Juliana Carvalho Rodrigues da Silva, Fábio Matoseiro Dinis and João Poças Martins. *Optimization of BIM-based Virtual Reality environments: a workflow proposal*. [355]
- Marina Krauze Thomaz, Denis Alcides Rezende and Lino Maia. Project: "E-Waste projects, strategies and public services and relation with strategic digital city". [359]
- Serra Danis and Humberto Varum. *Seismic Performance of Multistorey Flat Plate and Framed Structures with Shear Walls*. [192]

## **Keynote II – Eng. Tiago Braga (28<sup>th</sup> June, 16:00h-16:20h)**

**Topic:** *What to expect from a doctorate? A Company's Perspective.*

## **Technical Session II - (28<sup>th</sup> June, 16:20h-18:00h)**

**Topic:** **Transports and Spatial Planning - Moderated by Daniel Clemente**

- Mariana Pizzo Diniz and Miguel Serra. *Towards a Quantitative Approach to Morphological Regions in GIS* [200];
- Daniel Tavares, Mariana Pereira, Isabel Coimbra and Fernando Alves. *Heritage as a framework for governance and decision-making: a contextualization* [68];
- Ana Sousa, Tatiana Brandimiller, Tatiane Serrano and Isabel Coimbra. *DAMA – Decision-making, assessment & monitoring, and adjustment of contemporary spatial policies: a contextualization of exogenous challenges* [64];
- Ana Sousa and Sara Cruz. *Understanding Carrying Capacity: a bibliometric analysis* [141];
- João Teixeira, Cecília Silva and Frederico Moura E Sá. *The role of bike sharing during the COVID-19 pandemic: insights from Lisbon's GIRA users* [5];
- Isabel Cunha and Cecília Silva. *Bicycle Accessibility and Equity: assessing the socio-spatial impacts of Lisbon's Bicycle Master Plan* [57];
- António Lobo, Sara Ferreira, Anabela Simões, Liliana Cunha, Carlos Rodrigues, José Pedro Tavares and António Couto. *A human-centred approach to truck platooning* [56];
- João Martins, Álvaro Costa and Paulo Soares. *Reflection on the feasibility and location of an airport infrastructure in the Central Region of Portugal* [82].

## **Keynote III – Doutor Tiago Ferradosa (29<sup>th</sup>.June, 9:00h-9:20h)**

**Topic:** *The Joy of Reliable Scour Protections A PhD survival guide – the lessons I took*

## **Technical Session III - (29<sup>th</sup> June, 9:20h-12:30h)**

**Topic:** **Developments on Seismics, Hydraulics and Urban Forms - Moderated by João Pedro Martins**

- João Fragoso Januário, Álvaro Costa, Carlos Oliveira Cruz, Joaquim Miranda Sarmiento and Vítor Faria E Sousa. *Transport infrastructure, accessibility and spillover effects: empirical analysis of the Portuguese real estate market in the period 2000-2018* [133];
- João Fragoso Januário. *Seismic Risk and House Prices: cross-section modelling of Lisbon's real estate market* [134];

- Jeniffer Viegas, Pedro Baltazar-Soares, Giulio Vignoli, Jaime Santos and Fernando Santos. *Inversion of TDEM data constrained by surface seismic and borehole surveys for geotechnical characterization of the Northern Lisbon Logistic Park (PLLN)* [169];
- Carla Andreia Gonçalves. *The right to the waterfront: addressing climate and environmental justice from a landscape perspective* [143];
- Bonaventura Tagliafierro, Alejandro Crespo, Rosario Montuori and Ioannis Vayas. *Structural safety and computation: from seismic engineering to wave energy* [159];
- Beatriz Queirós, Francisco Taveira Pinto, Paulo Rosa-Santos and Alejandro Crespo. *Simulation of the stability of Antifer units applied on breakwaters using DualSPHysics coupling with Project Chrono* [172];
- Tomás Calheiros Cabral, Paulo Rosa Santos and Francisco Taveira Pinto. *Performance and energy production of a hybrid Wave Energy Converter* [164];
- Tomás Calheiros Cabral, Paulo Rosa Santos and Francisco Taveira Pinto. *Analysis of the functionality and stability of a dual-purpose breakwater-hybrid Wave Energy Converter* [165];
- Daniel Clemente, Paulo Rosa-Santos, Francisco Taveira-Pinto, Cátia Rodrigues, José Correia, Ricardo Esteves, João Ventura and André Pereira. *Recent developments on the E-Motions wave energy converter* [114];
- Francisco Pinto, Paulo Rosa Santos and José Victor Ramos. *Hydro and morphodynamic analysis of five segmented coastal protection structures: The case study of Carneiro Beach, Porto* [166];
- Kaíque dos Anjos Silva, Isabela Dantas Reis Gonçalves Basto, Andrea Sousa Fontes and Yvonilde Dantas Pinto Medeiros. *Analysis of the salinity variation downstream of the Xingó reservoir under the influence of outflows alteration* [163];
- Ana Margarida Bento, Andreia Gomes, João Pêgo, Teresa Viseu and Lúcia Couto. *A novel and pragmatic methodology for scour risk assessment at bridge pier's vicinity* [307];
- Luís J. Sousa, Miguel C. Gonçalves and Pedro Pinto. *Site Production Management: Case Study of the Digitalization of Construction Companies in Portugal* [330];
- Gustavo Lopes dos Santos and Beatriz Condessa. *Increasing Spatial Scales: Olympic Agenda 2020 and Portugal as Olympic Host* [99];

# KEYNOTE SPEAKERS

**Dr. João Pita**

*Head of Airline Business at the São Paulo International Airport/Guarulhos*

**Communication:** *I have a PhD and now what? A market perspective.*



Dr. João Pita is Head of Airline Business at GRU Airport – São Paulo International Airport. Over the last six years, Pita has held several positions at GRU Airport, where the biggest challenge is to continuously growth the business in a dynamic market. He also serves as the Latin America representative to the ACI Expert Group on Slots. João Pita is a Civil Engineer and has a PhD in Transport Engineering from the University of Coimbra in 2013.

**Eng. Tiago Braga**

*CEO of Metro do Porto*

**Communication:** *What to expect from a doctorate? A Company's Perspective.*



Eng. Tiago Braga, graduated in Environmental Engineering from the Escola Superior de Biotecnologia in 1998. He has been the CEO of Metro do Porto since 2019. Before that, he was a member of the Board of Directors of Águas do Centro Litoral.

**Dr. Tiago Ferradosa**

*Researcher*

*CIIMAR - Interdisciplinary Centre of Marine and Environmental Research*

**Communication:** *The Joy of Reliable Scour Protections A PhD survival guide – the lessons I took.*



Tiago Fazeres Ferradosa is a doctorate researcher at Faculty of Engineering of University of Porto and researcher at CIIMAR. Tiago is currently responsible for the R&D unit Offshore Structures & Foundations at the Research Group of Hydraulic Structures and Marine Energy. Tiago has been a visiting MSc researcher at University College London and developed his PhD thesis on the topic of reliability analysis of optimised scour protections for offshore foundations. He is also involved in the several R&D projects related to offshore engineering and marine renewable energy research, such as MARINET, HYDRALAB+, ORACLE, and I.nano.WEC. He performs co-supervision activities of master degree students in civil engineering at the University of Porto and has been responsible for the organisation of more than 15 conferences, courses, symposia and other scientific and professional events. He is the editor of the IAHR Newsflash Europe, member of the editorial panel in 4 international peer-reviewed journals, Guest Editor of SI in Renewable Energy (Elsevier) and reviewer in other 14 international peer-reviewed journals. Tiago is the author of several scientific peer-reviewed publications and organiser of the IOSD course series. He was President of the IAHR Portugal Young Professionals Network, the Coordinator of the Young Professionals of the Portuguese Association of Water Resources and elected member of the Monitoring Committee of the Civil Engineering Doctoral Program between 2016 and 2018. He is also the Business Development Manager at the IT engineering company SimpleAxis. He is the Portuguese appointed member of the Technical Committee 213 - Scour and Erosion. Dr. Tiago is also the awarded researcher of the APRH best PhD thesis of 2018/2019.

# ORAL PRESENTATIONS

## Mechanical behaviour of mortars including a hybrid cement and recycled aggregates

Filipe Almeida<sup>1</sup>, Ana Fernández-Jiménez<sup>2</sup>, Castorina S. Vieira<sup>3</sup>,  
Nuno Cristelo<sup>4</sup>, Maria de Lurdes Lopes<sup>5</sup>

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### Abstract

The achievement of several outcomes of the United Nations Sustainable Development Goals (UN 2015) depends on the commitment of the different areas of knowledge in delivering more environmentally-friendly solutions. Civil engineering has additional responsibilities within this context since the activities performed in the building and construction sector lead to significant environmental impacts and the generation of a high volume of construction and demolition waste.

Current research subjects within the framework of building materials involve the development of greener cements and the use of recycled aggregates in replacement of natural resources. Hybrid cements, which are a combination of ordinary Portland cement with alkaline cements (Qu et al. 2016), have been showing potential to be a trustworthy alternative within the domain of sustainable binders.

The aim of this work was to evaluate the mechanical behaviour of mortars having a hybrid cement with a high content of fly ash and recycled aggregates. Two features should be highlighted regarding the results. The first one is that the mortars manufactured with the hybrid cement and natural sand according to EN 196-1:2016 achieved considerable mechanical strengths. The other aspect is that the replacement of natural sand by high contents of recycled aggregates led to losses in the mechanical strengths of mortars. However, the mechanical behaviour of these mortars including recycled aggregates can be considered acceptable and may not represent a serious drawback in the case of exploiting the possibility of using these mortars in low-demanding engineering applications.

**Author Keywords.** Mortars, hybrid cements, recycled aggregates, mechanical behaviour.



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European Committee for Standardization. *Methods of testing cement - Part 1: Determination of strength*. EN 196-1:2016. Brussels, Belgium: CEN.

Qu, B., A. Martin, J.Y. Pastor, A. Palomo and A. Fernández-Jiménez. 2016. "Characterisation of pre-industrial hybrid cement and effect of pre-curing temperature". *Cement and Concrete Composites* 73:281-288. DOI: 10.1016/j.cemconcomp.2016.07.019.

Transforming our world: the 2030 Agenda for Sustainable Development - Resolution adopted by the General Assembly on 25 September 2015 (A/RES/70/1). *United Nations*.

# **Incorporation of the Sludge of Sewage Treatment Plant on Ceramic Bricks Manufacture**

Nara Cangussu<sup>1</sup>, Leandro Silva<sup>2</sup>, Stephanie Rocha<sup>3</sup>, Lino Maia<sup>4</sup>

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## **Abstract**

The treatment process used in most Sewage Treatment Stations (STS) generate as by-product a material named sludge. The amount of sludge grows proportionally with the increase in effluent collection and treatment services, which in turn must accompany population growth. The ceramic industry, due to its production characteristics, presents a great potential for the use of these by-product. The present work evaluates the effect of the incorporation of the sewage sludge in the ceramic mass for the manufacture of massive bricks. Real-scale test specimens were made without sludge addition and with 5%, 10% and 15% (by mass) addition of sludge to replace the clay. The specimens were characterized for linear retraction, water absorption, fire mass loss and compressive strength. The results showed that, for the addition of 15% of sludge, there is a reduction in compressive strength and an increase of water absorption.

**Author Keywords.** By-product, Sewage Treatment, bricks.

## **Workability control in the development of 3D printing cementitious mortars - laboratory methodology**

João Teixeira<sup>1</sup>, Cecília Ogliari Schaefer<sup>2</sup>, Lino Maia<sup>3</sup>, Bárbara Rangel<sup>4</sup>, Jorge Lino Alves<sup>5</sup>, Rui Neto<sup>6</sup>

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### **Abstract**

Properties in the fresh state are of great importance in the development of a 3D Printing Cementitious Mortar (3DPCM) by extrusion methods. The evolution of workability from mixing to extrusion influences the remaining 3D printing properties. This work presents a laboratory proposal to control workability in an initial phase of mix design of 3DPCM. Four mortars with different water/cement (w/c) ratios and these tests: slump, flow table, and V-funnel were carried out. Right after workability assessment, a mechanical extruder was used to extrude the mortars developed. The results of all tests are presented and compared with a qualitative analysis of extruded samples.

**Author Keywords.** 3D Printing, Cementitious Mortars, Construction, Extrusion, Laboratory analysis, Materials Development.

# Performance of low height railway noise barriers

João Lázaro<sup>1</sup>, M. Pereira<sup>1</sup>, Pedro Alves Costa<sup>1</sup>, L. Godinho<sup>2</sup>

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## Abstract

Rail transport is the most sustainable mode of transport, with the lowest energy consumption and carbon footprint. However, several reports (EEA 2019; Núria Blanes, Anna Marín 2019) point to the risks and the amount of population suffering direct exposure to rail noise. One of the most used railway noise mitigation measures is noise barriers (De Vos 2016). Despite the inherent benefits of noise reduction, the complaints of the population, who live close to the infrastructures, due to the size of the barrier is a problem that requires a solution for the future.

As the noise formation mechanisms are mainly at the track level (Thompson 2008), placing the barrier in a position close to the track allows the propagation of sound waves to be interrupted close to the source. Barriers of low height allow positioning close to the source without constituting an obstacle to the field of view. Several authors (Jolibois 2013; Morgan, Hothersall, and Chandler-Wilde 1998; Soundim 2009; HERING COMPANY GROUP 2014; Brens 2011) have worked on this issue to develop a solution that meets the requirements.

Thus this paper presents the methodology used in the creation of the acoustic barrier geometry and its acoustic optimization process. The numerical simulation was performed with the Boundary Element Method (BEM), widely used in acoustic problems. The parametric study presented herein compares the sound pressure levels obtained for the case with the rigid barrier and with absorbent material on the inner face of the barrier. This study focused on the area between the vehicle and the barrier to minimize reflections between the vehicle and the barrier.

Finally, considering the most efficient solution, the insertion loss in a network of receivers located 10m away from the track is analysed in order to study the noise reduction levels in a place where human receivers are usually located.

**Author Keywords.** Railway noise, Low height noise barriers, Acoustic efficiency, Noise mitigation

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# **Influence of Rail Damages on Dynamic Responses of Steel Railway Bridges under Vehicle Loading-A Review**

Nelson Traquinho, Rui Artur Bártolo Calçada, Diogo Rodrigo  
Ribeiro

## **Abstract**

The rail wayside monitoring of existing steel railway bridges permits the assessment of the actual behaviour and predict the healthy condition. This bridge category generally consists of steel lattice girders, and the steel elements in which the effects of the damage has the most influence on dynamic responses, are the longitudinal steel members and riveted connections. This document is devoted to discussing the influence of damages in dynamic responses of steel railway bridges, in a methodology based on a literature survey. From the reviewed articles, it was found that the steel railway bridges in which the stringer-to-floor beams connections are made from rivets, the rivet holes, controls the whole stringer fatigue damages. And, depending on the vehicle's speeds and it is running direction when the amplitude of rail corrugation increases and its wavelength decreases, the displacements and accelerations response caused by a rolling vehicle also increases, and the same happens with the rail squat damages.

**Author Keywords.** Rail damages, steel railway bridges

## **Vibrations Induced by Impact Pile Driving: Experimental and Numerical Analysis**

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### **Abstract**

In various construction sites, vibrations are considered a critical aspect. In particular, ones generated from the installation of driven piles. In this work, an experimental test site was developed for understanding of the phenomenon involved in the generation and propagation of vibrations. Additionally, the pile-ground system is modeled by an axisymmetric FEM-PML numerical model developed by the authors, allowing complement the experimental data. Thus, a set of parametric analysis was developed to evaluate the effect of fluctuation of some parameters, as pile penetration depth, drop-height, soil stiffness, soil damping, etc. The comparison between numerical and experimental results is a fundamental aspect, allowing the experimental validation of the numerical tool. Based on the investigation performed, it becomes very clear the suitability of the proposed numerical approach to predict the vibration levels at the ground surface. The estimation of the vibration levels expects in the early project phase can avoid possible constraints in the normal development of the construction activities, with economic and technical benefits.

**Author Keywords.** Pile Driving, Ground-borne vibrations, Numerical modelling, Experimental test site.

## Tensile response of reinforced UHPFRC elements

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### Abstract

The understanding of the tensile behaviour of Ultra-High Performance Fibre Reinforced Cementitious Composites with reinforcing steel bars (R-UHPFRC) is still limited as well as the existing guidelines for structural design. Therefore, the goal of this work is the development of a theoretical model describing the uniaxial tensile response of R-UHPFRC tension ties. The tension tie element is divided into a series of crack elements that are treated individually. An incremental and iterative procedure is used to find the overall load deformation response by ensuring equilibrium at each load step. The numerical load-deformation responses are comparable with existing experimental results from tensile tests, which validates the proposed methodology.

**Author Keywords.** Reinforced Ultra-High Performance Fibre Reinforced Cementitious Composite (R-UHPFRC), Mechanical model, Tensile behaviour, Tension Chord Model



## Artificial Intelligence for an Enhanced As-Is BIM Energy Analysis

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### Abstract

Facing the current pursuit for energy efficiency in the Construction industry, as well as the increase in Building Information Modelling (BIM) related practices, the present paper proposes a methodology to enhance the as-is BIM energy analysis (AIBEA) process, aiming to ease the energy retrofit of the existing building stock and allow for increased energy efficiency in the Construction industry.

The proposed methodology comprises the entire AIBEA process from contract formulation to building energy analysis, tackling several existing research problems such as: identification of contractual requirements and quality verification parameters for BIM energy analysis and the scan-to-BIM process; analysis of laser scanner parameters and its influence over the point cloud; optimal placement of laser scanner stations; artificial training of Artificial Intelligence (AI) algorithms; identification of construction materials in point clouds; among others.

**Author Keywords.** Enhanced as-is BIM energy analysis, Automated scan-to-BIM, Artificial Intelligence, Point cloud segmentation and classification, Data mapping and material recognition.

## **Digital Twins for Buildings Energy Management and IEQ within BIM Standard Specifications**

Mohamed Nour El-Din Abu Shamma, João Poças Martins, Nuno Ramos

### **Abstract**

One of the trending technologies that show a potential for efficient energy management and IEQ of buildings is Digital Twins (DTs). However, DTs still lack a clear definition, and that no standard functional requirements for their development are available. The feasibility of adopting DTs for energy management is, therefore, clearly diminished as building owners are unable to refer generically to this type of construction model when commissioning its development, let alone specify the requirements that must be met.

To help solve this issue, the authors propose the development of a DT (real-time) data exchange framework for building energy management and IEQ within Building Information Modelling (BIM) standard specifications, with the application on a real building case study using temperature and humidity sensors. This oral communication will focus on developing a flexible and low-cost open-source temperature/RH sensing device that will be used for integrating the monitored environmental data with the BIM.

**Author Keywords.** Digital Twins, BIM, energy management, IEQ, BIM standard, sensors.

## BIM Health and Safety Support Framework for Construction

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### Abstract

The construction industry still leads other industries with high numbers of injuries and fatalities annually. To have an effective site inspection, monitoring, and training, the AECO (Architecture, Engineering, Construction, and operation) sector gradually integrates new technologies such as building information modelling (BIM).

This paper presents a BIM-supported framework for Safety verification based on two main approaches: a Fully Automated Approach, adopting Automated rule checking, and a Fully Manual Approach, adopting Augmented and Virtual Reality (AR/VR) technologies. Moreover, this process will also enable safety training through AR/VR. The framework follows international standards such as ISO 1650, Directive 92/57/EEC, and PAS 1192-6:2018.

Integrating these technologies in a standardised manner will ease the adoption of the tools, enable clients to acquire a better perception and control of the H&S aspects of the project, assign specific tasks for each stakeholder, and involve H&S measures from the beginning of the project. Some limitations are found in implementing new tools, such as the lack of experience, low demand from the clients, incompatibility of software and data, high cost of hardware and software, and total time preparing BIM models.

**Author Keywords.** Building Information Modelling, Automated Rule Checking, Augmented Reality, Virtual Reality, Construction, Occupational Health and Safety.

## Exploring the Blockchain Adoption Directions in the AECO Industry

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### Abstract

Blockchain is a digital data and assets protection technology. The growing interest in exploring ways to adopt Blockchain within the architecture, engineering, construction, and operation (AECO) industry activities are expressed by the increasing number of studies discussing this topic. In order to visualise these directions, the article presents an evaluation of this topic available literature. Topics reviewed include Blockchain for BIM, construction processes and construction data integrity. The study contributes to the field by providing a concise evaluation of Blockchain in the AECO industry research and the recent development by highlighting main directions for Blockchain construction-related studies. The study aims to increase awareness about the topic.

**Author Keywords.** Blockchain, BIM, Intellectual property, Design

## **Developing a Construction Supply Chain System based on Lean Construction and Building Information Modelling supported Internet of Things standards**

Mahmoud Karaz, José Manuel Cardoso Teixeira

### **Abstract**

The construction supply chain is confronted with inefficient resource control and hindered by conventional approaches of production, which exacerbated the fragmented nature of information systems among various organisations. Thus, industry projects perform in siloes that hold vast disparities among production demand and supply; therefore, the current systems cause more wastes in production and environmental performances. Lean construction and Building Information Modelling (BIM) partially undertook that by collaborative platforms that control production on site. However, the construction still without a sufficient level of integration regarding logistics management. Therefore, this research aims to formulate CON4 system that combines information of logistics, production process and products, based on Lean-BIM and supported Internet of Things standards, to provide informed production decisions based on real-time information. CON4 could raise the situational awareness of on-site production, materials transportation, warehouse, and environmental impact.

**Author Keywords.** Production Theory, Construction Waste, Logistics Management, Connectivity

## Framework for the semantic enrichment of BIM models through a natural user interface

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### Abstract

The full-fledged uptake of Building Information Modelling (BIM) methodology is not yet acknowledged by all the actors involved in a construction project. In fact, due to the extensive variability of expertise among the various actors of the construction sector, not all have the necessary skills to interact with BIM models holding information. Conversely, Natural User Interfaces allow for streamlining the interaction process with digital tools so that, in a more democratic and inclusive way, the empirical knowledge of many actors in the construction sector can be capitalised.

This paper presents the work in progress of a framework based on a set of BIM information filtering mechanisms and interaction metaphors to streamline the information management process of enriching BIM models with an unsatisfactory Level of Information (LOI). Moreover, the semantic enrichment process focuses on Virtual and Augmented Reality interfaces and will be further validated using a holistic usability assessment methodology.

**Author Keywords.** Building construction, Building Information Modelling, Semantic Enrichment, Natural User Interfaces, Virtual Reality, Augmented Reality.

## **Towards a Quantitative Approach to Morphological Regions in GIS**

Mariana Pizzo Diniz, Miguel Serra

### **Abstract**

The concept of Morphological Regions and the method of Morphological Regionalisation stand out as very important contributions to the study of the historico-geographical structure of the urban landscape. Central to this method, is the understanding of the way in which urban landscapes are structured: the existence of unitary areas which comprise an individualized combination of the three basic form complexes, delimited by their degree of internal morphological similarity. However, from a methodological point of view, the identification of such areas (or morphological regions) remains based on qualitative visual analysis and on the personal expertise of the analyst. We propose to address the method of morphological regionalisation from a quantitative perspective, based on typological descriptions of urban form components derived by algorithmic means.

**Author Keywords.** morphological regionalisation; classification; typomorphology; GIS.

## **Heritage as a framework for governance and decision-making: a contextualization**

Daniel Tavares, Mariana Pereira, Isabel Coimbra, Fernando Alves

### **Abstract**

This short paper aims to provide a deeper understanding of the role of heritage within territorial governance, unrestricted by heritage management concerns. Heritage comprises the various uses, manifestations and understandings of the past in the present; it pertains to what people create and use in their daily lives, to processes of self and group identity construction, and negotiations of belongings to communities and places. As a framework, it prioritizes relationships that take certain types of knowledge and uses of the past as means to plan for the present and the future.

There is, however, little structured research on the view of heritage as a framework within governance and policy-making. Most existing literature focuses either on the manifestations of heritage, specific aspects of this thematic, or case studies.

Thus, the first step in answering this gap is the contextualization and theoretical justification of this understanding of heritage and its discourses, towards a definition of heritage as framework. Heritage is positioned, in this study, as a guiding approach as well as a pillar for sustainable development, instead of an object of policy-making. This view of heritage as a humanizer of spaces is desirable when working towards transformative, adaptive, participatory and knowledge-intensive forms of governance. Within this context, several fundamental discourses, or lack thereof, emerge: on living heritage, change and continuity beyond 'original function', the traditional dichotomy between tangible and intangible, and the temporalities and rhythms of heritage frameworks, among others.

**Author Keywords.** heritage frameworks, heritage as framework, sustainable development, transformative governance, knowledge co-production.



## **DAMA – Decision-making, assessment & monitoring, and adjustment of contemporary spatial policies: a contextualization of exogenous challenges**

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### **Abstract**

DAMA is a support, guidance and learning instrument. It aims to clarify, create structures, and capture knowledge on intervention practices, for the purpose of supporting decision-making in spatial policies, their evaluation and monitoring, and the adjustment or correction of their trajectory. Situated at the intersection of a wide range of theories and fields, this project is framed by a large and charged body of work, often entangled, sometimes at odds.

There is a need to harmonize and clarify the operationalization of guiding theoretical principles, as well as lessons learned through practice, through a critical look at the decisions and policies that affect a given territory. This work undertakes a first phase of research within the DAMA project. It seeks to identify, analyze and categorize the great exogenous challenges of contemporaneity which determine the trajectory of spatial policies: the acceptance of uncertainty, rapid transformation, and a high level of risk as the current status quo; or the uncertainty and risk tackled by complexity theory, among others.

Thus, this paper reflects on how these exogenous factors are defined, conceptualized and mobilized in the literature, by different theoretical areas and areas of research. It identifies and presents the main trends and components of contemporary challenges to spatial policies.

**Author Keywords.** spatial policies, decision-making, assessment and monitoring, trajectory adjustment and correction.

## Understanding Carrying Capacity: a bibliometric analysis

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### Abstract

Since the 18th century that the concept of carrying capacity has been employed throughout several disciplines, such as engineering and ecology. Nevertheless, it was in the 1950s, when debates concerning the world's overpopulation started to intensify, that the concept was adapted to the field of social sciences. The dichotomy between exponential population growth and an increasing awareness of the natural resources' finite nature – which are vital for the quality and survival of the human population – culminated into the conceptualization of human carrying capacity. The booming of urbanization introduced another dimension to the carrying capacity concept, adapting it to account not only for the land and food supply, but also for the anthropological activities sustained by them. The 'urban carrying capacity' concept was coined by Godschalk and Parker in mid 70s, who defined it as the natural and built environment capacity to sustain the demand of anthropological practices, absorbing their negative impacts with the least distortions possible.

Alongside the urban carrying capacity concept, other research trends within carrying capacity studies were developed, such as tourism and recreational carrying capacity, safety or disaster carrying capacity, ecological carrying capacity, and human carrying capacity. Through a bibliometric analysis, this short paper aims at mapping the state-of-the-art of carrying capacity studies whilst performing a quantitative data analysis of academic literature from the last 20 years.

**Author Keywords.** carrying capacity, bibliometric analysis, concept mapping.

# The role of bike sharing during the COVID-19 pandemic: insights from Lisbon's GIRA users

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## Abstract

COVID-19 has dramatically impacted urban mobility, of which public transport (PT) has been particularly affected. With PT ridership plummeting due to infection fears, there is a dangerous of a steep rise in car use that would exacerbate environmental and health problems. Therefore, other modes such as bike sharing should be considered as potential alternatives during the coronavirus pandemic. This study focuses on assessing how coronavirus has impacted bike sharing by implementing a travel behaviour survey to the users of GIRA, the bike sharing system (BSS) of Lisbon. While coronavirus has led some to decrease the frequency of use or quit the system, other users have increased the usage or joined GIRA during the pandemic. The survey has also revealed substantial changes not only on the usage patterns of GIRA's users but also in their relationship with other modes of transport. While before the pandemic, most respondents were shifting from PT to GIRA, that percentage has declined, with an increase on the share of users replacing walking, private car, and personal cycling. Moreover, the motivations for using bike sharing related with avoiding PT and maintaining a social distance during the trip have gained more relevance. Likewise, respondents now perceive PT to be the least safe mode. Policy insights can be derived from this research on how bike sharing can contribute to a more sustainable and resilient urban transport system. During infectious public health crises such as COVID-19, BSS can be a viable transport alternative, not only providing the population with an affordable mode of transport where social distancing can be maintained in most of the trip but also mitigating a modal shift from PT to the private car.

**Author Keywords.** COVID-19, Bike sharing systems, Modal shift dynamics, Public Transport, Car use, Safety perceptions.

## Acknowledgments

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# **Bicycle Accessibility and Equity: assessing the socio-spatial impacts of Lisbon's Bicycle Master Plan**

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## **Abstract**

Since sustainable mobility is highlighted in the urban agenda worldwide, cities have drawn attention and efforts towards strategies aimed at promoting the bicycle as a viable, accessible, and socially recognized transportation option. Notwithstanding, regardless of the importance of the social dimension within the sustainable mobility policy, empirical evidence revealed that bicycle investments are often unevenly distributed in cities in the global north and south. The present study hypothesizes that issues of equity have been far less addressed during planning and decision-making processes, with starter cycling cities facing the hardest challenge of planning synergic strategies to tackle issues of social equity, as well as other parallel planning priorities. Thus, aiming to support planners towards more equitable approaches, this research introduces a planning-support tool, which assesses the potential of bicycle planning and infrastructure provision to reduce socio-spatial inequalities in access to opportunities. The Bicycle Master Plan under development in Lisbon, Portugal, offered the testbed for the application of the proposed method. Therefore, to assess the equity impacts of current and future scenarios, sociodemographic data, spatial information, and GIS analysis were examined at the census tract level. On the one hand, the spatial analysis measured the accessibility gains towards essential activities and opportunities provided by the city (i.e., education, health, grocery, social services, and public transportation). On the other hand, the social analysis explored to what extent the increased bicycle accessibility is distributed over socio-advantaged and disadvantaged population groups. To conduct such analysis, the adaptation of the Gini index and the Lorenz curve explored the distribution of cumulative accessibility across the resident population, whilst ratios pairwise comparisons identified disparities between advantaged and disadvantaged segments. The ex-ante analysis revealed increased accessibility to parks, grocery, and health opportunities, reflecting a more equitable distribution of accessibility over distinct areas of the city and population groups. Yet, by comparing Gini coefficients, the accessibility to social services did not depict significant improvement. Likewise, the ratios comparisons demonstrate that advantaged segments have better accessibility conditions in both current and future scenarios, with higher discrepancies between highly educated and illiterate groups. The elderly, immigrants and non-car users would benefit from increased accessibility after the implementation of the Bicycle Master Plan. All in all, the full operationalization of the proposed planning-support tool assesses to what extent bicycle plans are equitable, revealing where and to whom the cycling infrastructure provides the most important outcome, in terms of social inclusion and mitigation of spatial and social inequalities. Such ex-ante assessment aims to support planners, practitioners, and decision-makers towards more equitable strategies in starter cycling cities.

**Author Keywords.** Bicycle Master Plan, Equity, Accessibility, Starter Cycling City

## **A human-centred approach to truck platooning**

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### **Abstract**

The concept of truck platooning comes from the linking of two or more trucks driving on the road very closely in convoy. The first truck is the leader and the following truck(s) react and adapt their speed and lane position without human action, using driving automation and vehicle-to-vehicle communication. This coordinated movement reduces fuel consumption, CO2 emissions and traffic jams, but most important, improves road safety and drivers' working conditions. However, during the transition to full automation, the driver will still be kept "on the loop", as he/she will still be responsible for supervising the driving task. Therefore, truck platooning is a totally new technology that requires deep human factors research to avoid compromising road safety by the introduction of new and unexpected risks.

The project TRAIN will identify the risks and requirements for a human-centred development of truck platooning technology. First, TRAIN will engage professional truck drivers and freight companies in focus groups interviews and in nationwide questionnaires to identify their mental representations about truck platooning and to develop a technology acceptance model.

Then, driving simulations will be conducted to assess the main risks associated with truck platooning under automation levels 2-3. The simulations will be designed to (i) evaluate drivers' understanding of the system and their situation awareness, and (ii) test safe following distances, considering the trade-off between safe takeover and the probability of platoon disruption by a car cutting into the gap between trucks. The data collected will allow predicting the evolution of drivers' alertness across time and to derive safe and efficient thresholds for takeover and following distances.

In the end, TRAIN will deliver essential guidelines to the truck platooning industry, operators and authorities, centred on the training needs and risk factors associated with a safe and acceptable deployment of truck platooning on public roads.

**Author Keywords.** Truck platooning, Road safety risks, user acceptance, driving simulator.

### **Acknowledgments**

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## Reflection on the feasibility and location of an airport infrastructure in the Central Region of Portugal

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### Abstract

The idea of an airport in the Central Region of Portugal is defended by mayors, local industry leaders, residents and as well as emigrants from this region. This purpose is based on the fact that this region is highly industrialized and densely-populated and the region's potential as a travel destination. Due to the impacts that an airport has on the territory and on the transport system, it requires careful planning, especially spatial planning, and economic-financial planning. Therefore, in the context of this problem, it was sought to analyse the feasibility of this airport infrastructure, as well as the possible locations to host it. The existing airfields were characterized and the possibility of expanding their runways was analysed, as well as the existence of space for the construction of all the infrastructures necessary for the service that a modern airport requires. In the case of air bases, their strategic-military context was also analysed. With the aerodromes that best fit these criteria, considering the location of Fátima, a comparison was made between the different locations through an analysis of the transport system and accessibility. After this study, the results show that the creation of an aerodrome/airport in this region is feasible, from all points of view, allowing us to suggest the best location.

**Author Keywords.** Feasibility, Airport location, Airport infrastructure, Central Region of Portugal, Spatial Planning.

## Transport infrastructure, accessibility and spillover effects: empirical analysis of the Portuguese real estate market in the period 2000-2018

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### Abstract

Modelling housing prices has long stood as a central research area within urban and regional economics. Several studies have accessibility has been one of the main factors affecting housing valuation (Bowes and Ihlanfeldt 2001; Shin et al. 2007; Martinez and Viegas 2009). This article describes the influence of transportation infrastructure on property valuations, using the mean value of real estate transactions within administrative regions NUTS-III in continental Portugal as a proxy for its valuation between 2000 and 2018, explicitly considering spillover effects from investing in infrastructure. We developed a cross-regressive spatial model with controlling for investment and infrastructure stock and accessibility. The results show evidence of spatial autocorrelation between real estate values, confirming that the positioning of each region is crucial for the development of the market. However, the results are not consistent across all 23 regions, showing positive and negative impacts of road infrastructure investment in real estate values.

**Author Keywords.** Real Estate, Transport, Accessibility, Investment, Hedonic models

# Seismic Risk and House Prices: cross-section modelling of Lisbon's real estate market

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## Abstract

House prices are a function of several internal and external factors to the property, usually reflected in hedonic pricing models. Traditional economic modelling assumes a rational decision-making process of homebuyers, and thus the perception of risk should also be reflected in property prices. Several authors have analyzed the relationship between natural hazard risk and housing prices and found evidence of changing market dynamics, especially after hazardous events (Palm 1981; Asgary 1997; Fekrazad 2019). However, market responses seem to vary across cultural, geographical and socio-economic contexts. The southern part of continental Portugal is considered to be of moderate seismicity due to its proximity to the Azores-Gibraltar fault, having registered two significant earthquakes in 1531 and 1755 (Borges et al. 2000). This paper assesses the relationship between seismic risk and housing prices in the city of Lisbon, developing a cross-sectional spatial regression model, using spatially lagged exogenous regressors, over a sample of 4248 property sales between 2008 and 2018, using yearly-standardized sales prices. The results show no clear preference for lower seismic risk zones. Homebuyers appear to be oblivious to the seismic risk, which may lead to an increased number of lives at risk as well as significant economic losses. This may result from unawareness of seismic risk or biased perceived susceptibility due to no experience of a recent event (Dooley 1992; McGinnis 2004), which is especially concerning given that half the stock in Lisbon is composed of unreinforced masonry buildings built before any seismic code provision (Simões 2014). These findings provide evidence of the need for urban development policies to raise awareness of the seismic risks and prompt private action to reinforce the existing building stock.

**Author Keywords.** Real Estate, Seismic Risk, Policymaking, Urban development, Spatial Regression



# **Inversion of TDEM data constrained by surface seismic and borehole surveys for geotechnical characterization of the Northern Lisbon Logistic Park (PLLN)**

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## **Abstract**

Investigate the earth's interior and identify its structure and materials distribution, as well as to characterize its geomechanical parameters, are the base for any further project since for the development of foundation projects the knowledge of the subsurface is critical. The application of geophysical methods for geotechnical characterization has become a common practice due to the possibility of investigating large areas in a short time, with a great ratio of cost-effectiveness. This paper presents a study case where the inversion of Time Domain Electromagnetic Data (TDEM) constrained by a reference model created with information from seismic surface waves and boreholes was applied to investigate the subsurface of the Northern Lisbon Logistic Park. The goal was to understand how important prior information is for the inversion of TDEM data, and how well this technique can describe the subsurface. By coupling diverse techniques, we got an image with more information from the subsurface, for example in this study, we identified the shallowest layer and its thickness.

**Author Keywords.** Geotechnical Characterization, TDEM, Inversion, Surface Waves

# The right to the waterfront: addressing climate and environmental justice from a landscape perspective.

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## Abstract

Waterfront's megaprojects are considered a flagship of the neoliberal movement, reflecting changing forms of labour and manufacturing (Harvey 1989; Sager 2011; 2015). Waterfront redevelopment carries out relevant cultural, environmental, and economic functions. However, several planning conflicts have been identified related to land ownership, heritage and culture, social and environmental justice, and environment and resilience, among others (Avni and Teschner 2019). Due to climate change, growing concerns over climate and environmental justice will continue to challenge waterfronts in the future (Bautista et al. 2015; Mohai, Pellow, and Roberts 2009). Within Europe, the European Landscape Convention (Déjeant-Pons 2006) has reinforced the debate regarding the concept of the landscape itself but especially providing a way of understanding the relationship between ideas of justice and the practice of landscape (Groening 2007; Olwig 2007). Based on a comprehensive review of the state-of-the-art literature, this essay focus on how can planning address climate and environmental justice in waterfront developments in general and through the European Landscape Convention in particular. Conclusions show the advantages of addressing climate and environmental justice through a landscape lens in waterfronts.

**Author Keywords.** urban environmentalism; green gentrification; inequality; sustainability; cities; spatial planning.

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## **Structural safety and computation: from seismic engineering to wave energy**

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### **Abstract**

In this work, two emblematic case studies are presented that involve the use of high-end numerical simulators to evaluate the response of structure systems under hazardous natural phenomena. The performance of two devices – a seismic isolator for pallet racking systems and a point-absorbing wave energy converter – are investigated. These are currently under development, and have been investigated through analyzes whose purpose is to evaluate their performance and reliability under extreme events: earthquakes and storms respectively. Numerical simulations with physics engines, ever since related only for non-scientific purposes, can now complement scientific projects targeted at developing novel concepts, mostly related to low-budgeted research.

**Author Keywords.** Numerical modelling, OpenSEES, DualSPHysics, Project Chrono, Coupling, Structural safety, Design methodology.

## Simulation of the stability of Antifer units applied on breakwaters using DualSPHysics coupling with Project Chrono

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### Abstract

Rubble mound breakwaters are the most used structures for coastal protection, working like obstacles to the natural propagation of ocean waves and effectively promoting wave energy dissipation. Traditionally, to assess the hydraulic and structural behavior of rubble mound breakwaters, physical models were used. Nowadays, there was a remarkable evolution in the application of advanced numerical models, like the meshless method smoothed particle hydrodynamics (SPH), to an extensive range of complex hydrodynamic phenomena in the field of coastal and port engineering. The complementary use of physical and numerical models allows performing a comprehensive study of complex phenomena related to the interaction of waves with the breakwater in terms of wave loadings, overtopping, and damage assessment. The present manuscript aims to use high-resolution and accurate results from physical model tests to validate the application of DualSPHysics solver on the simulation of the fluid-structure interaction and the interaction among different bodies (e.g., sliding Antifer units) by coupling with Project Chrono.

**Author Keywords.** Rubble mound breakwaters, Antifer, damage, numerical modelling, SPH, DualSPHysics, Project Chrono.

## Performance and energy production of a hybrid Wave Energy Converter

Tomás Calheiros Cabral, Paulo Rosa Santos, Francisco Taveira  
Pinto

### Abstract

Ocean waves are an abundant and predictable energy source, albeit virtually unexplored. This paper presents the design and optimization of a ground-breaking hybrid Wave Energy Converter (WEC), the h-WEC, which combines an Oscillating Water Column (OWC) and an OverTopping Device (OTD), and is integrated into rubble-mound breakwaters. Physical model tests were carried out at a scale of 1:50 to assess the wave energy conversion efficiency of three different geometries of a 20 m wide device (full-scale) integrated into the cross section of the planned 300 m extension of the North breakwater of the Port of Leixões, Portugal. Afterwards, the annual electricity production of the device was estimated for this case-study location.

Tests with regular waves permitted to conclude that the hybridization leads to higher efficiencies compared to each individual component, and for a broader range of wave conditions. The concepts complement each other well: the OTD was more efficient for the lower wave periods tested and the OWC for the higher. This is a major advantage of the dual-WEC system because it allows a more constant power production, which is usually difficult to obtain in the renewable energy sector.

Subsequently, the device was tested for seven irregular sea states covering 97% of the annual wave energy resource and 84% of occurrences, and three water levels, representative of the mean annual resource at the location, to determine its mean annual electricity production.

The 20 m wide device reached an overall efficiency of 44.4%, a wave-to-wire efficiency of 27.3% and the annual electricity production was estimated at 35 MWh/m. A 240 m wide device (full-scale) could provide more than half of the port's electricity consumption. The h-WEC evidenced a good performance harvesting wave energy, although further research will be developed to increase its Technology Readiness Level, namely through PTO optimization and control.

**Author Keywords.** hybrid wave energy converter, energy self-sufficiency, oscillating water column, overtopping device, physical modelling.

# **Analysis of the functionality and stability of a dual-purpose breakwater-hybrid Wave Energy Converter**

Tomás Calheiros Cabral, Paulo Rosa Santos, Francisco Taveira  
Pinto

## **Abstract**

Ocean waves are an abundant and predictable energy source, albeit virtually unexplored. This paper presents the design and optimization of a ground-breaking hybrid Wave Energy Converter (WEC), the h-WEC, which combines an Oscillating Water Column (OWC) and an OverTopping Device (OTD), and is integrated into rubble-mound breakwaters. Physical model tests were carried out at a scale of 1:50 to assess the wave energy conversion efficiency of three different geometries of a 20 m wide device (full-scale) integrated into the cross section of the planned 300 m extension of the North breakwater of the Port of Leixões, Portugal. Afterwards, the annual electricity production of the device was estimated for this case-study location.

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**Author Keywords.** hybrid wave energy converter, energy self-sufficiency, oscillating water column, overtopping device, physical modelling.

## Recent developments on the E-Motions wave energy converter

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### Abstract

This extended abstract summarizes the latest developments regarding the E-Motions, a promising wave energy device capable of converting wave/wind induced roll oscillations of multipurpose offshore floating platforms into energy. This concept has been subjected to an experimental study (1:20 geometric scale) for three hull designs: half-cylinder, half-sphere and trapezoidal prism. The study encompassed free decay and inclination tests, as well as subjecting the variants to various combinations of wave height and wave period (parametric approach, regular waves, and case study sea-states). Outcomes point towards an overall good hydrodynamic response for the half-cylinder, while the half-sphere and, particularly, the trapezoidal prism require design adjustments (shape, dimensions and/or mass distribution). Values for the average power reached up to 13.36 kW, 8.19 kW and 4.17 kW, respectively (regular waves). Upcoming developments involve a numerical modelling stage that includes an optimization procedure for operational wave conditions (ANSYS® Aqwa™), and a survivability analysis (DualSPHysics).

**Author Keywords.** E-Motions, Marine renewable energy, Physical modelling, Numerical modelling, Performance optimization.



# **Hydro and morphodynamic analysis of five segmented coastal protection structures: The case study of Carneiro Beach, Porto**

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## **Abstract**

Beaches and the adjacent seafronts can be hardly affected by extreme events. Detached breakwaters are one coastal protection solution to better shelter the coastline and consequently urban coastal areas in those cases. To mitigate the consequences from overtopping and storm events in the Carneiro beach in Porto, five detached breakwaters were designed. This paper presents the conclusions of the numerical study performed to assess the impact of those structures in the local hydro- and morphodynamics, as well as the research topics that should deserve further attention in the subsequent research works. The Delft3D-WAVE module was used to propagate waves to the coast, the Delft3D-FLOW module to simulate the hydrodynamic conditions and the Delft3D-MORPHOLOGY module to reproduce the sediment transport. With this integrated modelling approach, it was possible to analyze the effectiveness of the five structures designed to shelter Carneiro beach. Those structures were capable to provide calmer conditions on the lee side, although relevant scour phenomena occur mainly on the head section of the breakwaters.

**Author Keywords.** Delft3D, Detached Breakwaters, Sediment transport, Coastal Erosion.

## **Analysis of the salinity variation downstream of the Xingó reservoir under the influence of outflows alteration**

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### **Abstract**

This paper aims to analyze the effects on the salinity parameter caused by changes in the outflows of the Xingó reservoir (Brazil). The methodology consisted of collecting information to identify if there was, or not, an influence in the salinity conditions of the water due to the alteration in the hydrological regime of the river. To this end, observed daily flow data and simulated with the Mike 11 numerical model were compared. The analysis considered three distinct hydrological periods: wet (September 2008 to October 2009); dry (May 2017 to April 2018); and a peak flow of 3,000 m<sup>3</sup>/s (February 2021). The analysis of the data from the studied period demonstrated that the existence of a flood would cause a dilution of salinity throughout the channel of the studied stretch, making it possible to meet the limit adopted by CONAMA Resolution No. 357/2005 for freshwater class 2.

**Author Keywords.** Hydrodynamics, Salinity, São Francisco River.

## **A novel and pragmatic methodology for scour risk assessment at bridge pier's vicinity**

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### **Abstract**

Bridges crossing waterways are susceptible to collapse due to the local scour phenomenon, one of the greatest threats to the stability and safety of these hydraulic infrastructures worldwide. For the safe operation of bridges and their foundations it is of primordial importance to understand the inherent risk. However, the number of studies addressing scour risks and vulnerability is still reduced, which highlights the need for a systematic, coherent and straightforward methodology for assessing the scour risk of bridges.

A scour risk assessment involves the outcomes that could result from a combination of drivers, hazard events, and the performance of the bridge foundations when subject to those events. There are still many uncertainties affecting the design process of bridge foundations. Hydrological events, hydraulic conditions, bed morphodynamics and bridge pier characteristics are examples of the many underlying uncertainties that should be considered, in recognition of their influence on the scouring phenomenon and the resulting bridge scour risk.

Therefore, a new and pragmatic scour risk assessment methodology is herein presented. This is a three-step methodology that comprises: (i) the hydrological modelling of extreme events; (ii) the computation of flow and scour variables to model river behavior; and (iii) the assignment of a bridge scour qualitative risk rating based on the relation between relative scour depth and the vulnerability of the infrastructure in question. A Portuguese bridge case study was used to validate the proposed methodology, selected due to the changing bathymetry records over time at the bridge site and the availability of relevant flow monitoring data. The methodology has proved to constitute a useful tool for providing risk management measures and in assisting the prevention of catastrophic events.

**Author Keywords.** bridge piers, hydrological modelling, local scour, risk assessment.

## Site Production Management: Case Study of the Digitalization of Construction Companies in Portugal

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### Abstract

Given that its low-skilled labour, low level of digitalization and information integration, characterizes the construction industry it suffers from low productivity and low efficiency compared to similar industries. (Calvetti 2021) (Martins 2009)

From this perspective, this work intends to explore alternatives and outline guides for obtaining data from the construction site, to improve production management on-site through the control of labour, considering the technical capacity of field-based workers. Through the application of technologies, namely mobile applications, is intended to accelerate the transmission of information and the perception of productivity in time to allow managers the power to make educated decisions, removing friction from the control process and the lack of knowledge.

**Author Keywords.** Building Construction, Mobile Application, Management, Raken, Procore, Integration

## Increasing Spatial Scales: Olympic Agenda 2020 and Portugal as Olympic Host

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### Abstract

Recent bidding cycles for hosting the Olympic Games have struggled to attract interested cities due to public opposition against the unsustainability of the event. To mitigate such problem, the International Olympic Committee (IOC) has recently adopted the Olympic Agenda 2020 (OA), which has already driven important changes regarding the Games' urban concept, including the possibility of countries being hosts. This paper compares a previous academic study regarding a hypothetical case of Lisbon bidding to host the event with a new study considering the entire country of Portugal as bidder. It pays especial attention to the country's existing venues, facilities, infrastructures, and planned interventions, as well as to the national territory planning policies in force. Findings show that the OA can generate greater opportunities for the country's territorial development, namely regarding issues of migration patterns, territorial diversity and inclusiveness, polycentrism, and mobility, but requiring larger infrastructure investment.

**Author Keywords.** Olympic Games, Olympic Agenda 2020, Mega-Event Planning, Spatial Planning, Transport Planning and Territory.

# POSTERS

## Investigating the Retaining Wall Stiffness Relative to the Stiffness of Surrounding Soil in Order to Find the Exact Position of Base Level of Buildings

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### Abstract

Structure analysis for the dynamic forces and specially the earthquake is of great importance. However, determining the location of the base level except for the reinforced concrete retaining walls that are present in most of the basement area depends on the other factors such as the location of the foundation relative to the first floor level, soil conditions surrounding the structure and walls, the presence of openings in the basement walls, location and amount stiffness of lateral vertical load-bearing elements and the type of structural lateral bearing system, using or not using the seismic separation system, depth of the foundation, proximity to adjacent buildings, and slope at ground level, rigidity or flexibility of building floor at the level near the soil level around the structure, state of connecting the floor diaphragm to the retaining walls, relative stiffness of retaining wall to structural stiffness, and the type of soil behind the wall. This study pursues the change procedure in the base surface level location by investigating the way that different factors affect the proportional stiffness of soil into the retaining wall, and by assuming the other factors constant, determines the base surface level location by considering the change in stiffness ratio of soil and the retaining wall. This study investigates the conditions originating from the change in the surrounding soil stiffness by nailing in half-buried structures under the seismic force by using numerical simulations via FLAC3D three-dimensional analysis software. The results of the model analysis indicate that with increasing stiffness of the soil around the buried structure, the base level location changes relative to the structure retaining wall by the nailing protection system, being below the ground level in some cases, and in the absence of the nail protection system, the rate of the structure roof displacement will be different.

**Author Keywords.** Base surface level; soil stiffness; retaining wall; dynamic load; half-buried structures; nailing; finite difference method.

# Concrete with coarse aggregates partially replaced by recycled construction and demolition waste

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## Abstract

The concern with solid wastes has been discussed for some decades in the national and international domains, due to the increase of collective awareness regarding to the environment. The current work aims to analyze the technical ability to produce concrete for non-structural purposes with the coarse aggregate coming from recycled concrete and other construction and demolition waste. Reference specimens were made without the addition of recycled aggregates, i.e. with natural crushed gravel was used as reference. The gravel was replaced by 25%, 50% and 75% coarse recycled aggregates. Concrete strength and workability testes were carried out. Results showed higher concrete strength values for concrete made with recycled aggregates. The replacement of 25% of the gravel by the recycled coarse aggregate resulted in a 21% increase in strength when compared to the reference mix. Then, for the materials tested, it was concluded that the replacement of the natural crushed gravel by recycled aggregate concrete can be carried out in fractions of at least 75% without loss in the compressive strength in the concrete.

**Author Keywords.** Recycling, Coarse Aggregate, Recycled Aggregate Concrete.

## City Archive: A tool for raising a city from the ashes. The case of Aleppo, Syria

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### Abstract

The study concerns the multiple threats continually facing the world's cultural heritage during crises. It intends to shift the interests of urgent reconstruction practices to the importance of building City Archive and explore its values for urban recovery and cultural identity protection. The paper would discuss how we might employ this concept of method to regenerate a destroyed space with an inherited cultural and historical significance. At the same time, it draws attention to the role of collective memory and active citizenship in relation to the city archive within post-war settings. This research aims to propose a theoretical model for continuing and reproducing features of City Archive as model of collective memory and culture-led generation of the historic urban spaces. The study would be pursued through a theoretical discussion, analysis of the scientific production and experiences that are related to such issues. It would apply also a qualitative method via field study and in-depth interviews with expertise in this archival field, architectural and conservation professionals, residents/immigrants who are known as local residents to the case study. The paper is timely research joining the ongoing ones to protect cultural heritage and shared identity. Thus, the hypothesis may be more open and could productively inform debates and practices relating to urban cultural memory. It would end with some concluding thoughts on the role of city archives in rebuilding war-damaged cities as well as in the spatial urban-based cultural memory studies and the broader theoretical and practical implications in relation to space, archive and memory. It would take the Old City of Aleppo as a piece of study for investigation after its massive destruction in the recent war but expands that exploration through a number of case studies. The paper positions its questions and objectives to investigate the roles of city archive and collective memory as tools for rebuilding the city and protecting its cultural heritage.

**Author Keywords.** Cultural Heritage, Aleppo, City Archive, Culture-led regeneration, Collective memory, Urban Identity



## Development of an extruder for laboratory testing of 3D printing mortars

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### Abstract

The commercial price of small-scale 3D printers is not yet accessible for many research groups, hindering the development of 3D printing mortars. Trying to find an answer for this problem, the authors developed a low-cost extruder for cementitious materials, adapting an existing system developed for a different project - ADIMAQ (Neto et al. 2017). The system uses a load applied by the downward movement of the piston to push the material through a nozzle, like the systems used in 3D printing with ceramic materials. During extruder design, these requirements were considered: i) keep the largest number of constituents and fittings of the previous system, allowing us to install the new extruder into the structures developed for the ADIMAQ project; ii) increase the piston pressure on the material; iii) to enable the extrusion of high-thixotropy materials; and iv) to enable nozzle changes.

To comply these requirements, these changes were made: the extruder body diameter was reduced, allowing higher pressures without the need to increase the force applied by the piston; pneumatic actuators have been included close to the nozzle to assist the extrusion of high-thixotropic materials; a screw system was developed to allow nozzle exchanges. Dimensional changes were made only in the extruder body and piston head, all other constituents were kept.

Since it was developed the extruder has been tested with several cementitious compositions with different rheological properties. The constituents used in these compositions were: metallic fibres, superplasticizers, mineral additions (limestone filler, fly ashes, silica fume and metakaolin), and sands. The inclusion of superplasticizers, increased the viscosity of the mixtures, requiring the use of pneumatic actuators. In an initial phase, the extruder was tested in a system with manual movements (Teixeira et al. 2021), being used later in a 5-axis printer (Neto et al. 2017).

**Author Keywords.** 3D printing, Cementitious materials, Extruder development, Laboratory testing

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## Designing Cities for Sustainable Mobility Mindsets

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### Abstract

The concept of sustainability in mobility has gained a new momentum when faced with a new pandemic challenge that required cities to adapt to a new reality of confinement and limited mobility. Issues such as traffic congestion, air and noise pollution and resulting climate change and health problems that were once pushing for more sustainable means of transportation to be prevalent in cities, may now suffer a setback when social distancing is a new norm for personal safety. If most cities were considered car-oriented in their design, as well as in their population's mindset, before the pandemic, how can we prevent the aggravation of this vicious cycle of car use and car-oriented planning?

This thesis aims to contribute to the discussion of this problem by assessing the impact of different urban designs on the mobility mindsets of the population, moderated by place attachment and influenced by a new perception of the environment and associated risk due to Covid-19. By analysing Portuguese case-studies in neighbourhoods with design characteristics that support different modes of transportation and where sustainable mobility projects were implemented, it is possible to identify the psychosocial repercussions on mobility of short and long-term public space interventions on the neighbourhood's residents and their overall mobility mindset. With the support of online surveys, the mobility mindsets of the respondents were mapped and results revealed that the mindsets were correlated with the perception of the environment of their residential area and that the pandemic changed their routine mobility behaviour.

This insight of how the environment affects the way we think, move within our cities and support sustainable modes of transportation will help tailor municipalities' mobility strategies not only while facing emergent challenges like a pandemic, but also long-term problems such as climate change, both being threats to the health and sustainability of the future.

**Author Keywords.** Urban Planning, Urban Design, Mobility Mindset, Mobility Behaviour

## Evaluation of concrete pavers using plastic as fine aggregate

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### ABSTRACT

Polymers are manufactured in large scale, however, their recycling does not reach large proportions in countries like Brazil. This material can be incorporated into products used in civil construction, as this sector has been standing out in the use of waste, reducing the consumption of natural resources. The purpose of this study was to evaluate substitution of natural aggregate by plastic waste in pavers to decrease the amount of waste in landfills. Dimensional evaluation, water absorption tests, compressive strength and abrasion strength were carried out. According to analyzes carried out, the pavers with plastic did not reach values for the compression required in Brazilian norms, however, it is suggested that the strength found is suitable for walkways.

**Author Keywords:** pavers, sustainability, recycling, plastic waste, construction materials.

## BIM as a tool for Facility Management

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### Abstract

Facility Management (FM) involves spaces, people, and processes to manage a built environment with or without technology. The use phase is the longest of the life cycle, which requires a high financial resource and all the building information generated during the life cycle should be stored reliably. Therefore, BIM (Building Information Modelling) technology has been associated with FM due to its ability to offer a reliable database regarding the components of the models, to have a digital representation of the building, which results in maintenance benefits and all building's life cycle. This study aims to show the benefits and some challenges to use BIM as a tool in FM. The results indicated that the use of BIM-FM brings benefits to the maintenance of a building. However, the adoption of this methodology requires changing the work process, maturity level, improve the accuracy of model information, and the adoption of new technologies.

**Author Keywords.** Operations, Maintenance, Life Cycle.

## Application of silica fume in cored concrete blocks

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### Abstract

The present work proposed the partial replacement of the Portland cement by silica fume in cored concrete blocks with dimensions 14x19x39 cm. Silica fume is coming from the mining and metallurgical companies. Test specimen were produced for the reference mix and for mixes where the Portland cement was partially replaced by silica fume at the rates of 5%, 10%, 15% and 30%. Some physical and mechanical tests were carried out. All mixes reached the acceptance requirements for water absorption, net area and for dimensional stability. Compressive strength values were below the minimum required. The performance of silica fume was satisfactory for replacements of 10% and 15% mix with an increase of compressive strength at rates of 9% and 29% respectively.

**Author Keywords:** masonry, silica fume, sustainability, materials and construction.

# Treatment of cassava starch bagasse for use as pozzolan in cementitious materials

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## Abstract

As well known, the correct solid waste disposal still a recurrent issue in the society, that aims to not only find solutions for the correct disposal of these materials, but also to create process to systematically reinserting them in production. According to the Food and Agriculture Organization of the United Nations- FAO, the production of cassava in the world in 2018 was 277.8 million tons. Fecular factories are one of the types of companies responsible for processing cassava and the bagasse is one of the remant products of the whole process. Leonel and Cereda (2000), have shown that for a ton of cassava used in the starch manufacture, are generated around 928.6 kg of bagasse with 85% humidity. Furthermore, the uncontrolled disposing of the raw residues from cassava into the environment can cause serious contamination problems (PEIXOTO and RESH, 2018). Thereby the reuse of these waste from agribusiness becomes crucial for environmental and also has financial reasons.

Salau and Olonade (2011) investigated the pozzolanic potential of cassava peel ash, and their results have shown that cassava peel ash has pozzolanic reactivity for calcining at 700°C for 90 minutes. An add-value opportunity was identified for cassava industry by-products, as the ashes from calcining cassava can be used in the construction industry as partial replacement of cement.

So, the objective of this work was to treat the cassava starch bagasse and study the amenities of this product in partial replacement of cement, as well as the energy recovering during the calcining process. There were performed characterizations to parametrize this entire process: Fire loss and FTIR tests. The initial results after drying for 48 hours at 150°C reaches a brittle characteristic and the ball milled samples was visually homogeneous. The calcining tests were also performed at temperatures of 650°C and 900°C. The complementary FTIR measurements were used in the structural characterization of ash. The cassava starch bagasse ash FTIR results show peaks of silicate group formation, at coincident points such as 1080 and 1400 cm<sup>-1</sup>. This indicates that the burning of this by-product causes calcination and generates ash that may contain amorphous silica. Therefore, we anticipate that the material shall have pozzolanic properties, but more research is required.

**Author Keywords.** Cassava bagasse ash; pozzolan; heat treatment.

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## E-Waste projects, strategies and public services and relation with strategic digital city

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### Abstract

The largest growing waste stream in today's society is electrical and electronic waste (e-waste). To understand the dimension of this problem and what mitigative actions are being adopted, it is crucial to review projects, strategies, and services currently being implemented to address it. The objective of this research is to identify and assess existing e-waste projects, strategies, and public services and their relations with the concept of strategic digital cities. This research focuses on the city of Curitiba, the capital of the state of Parana in Brazil. More specifically, this work aimed at surveying local initiatives and reveal points where the implementation of current initiatives with respect to e-waste can improve. Representative e-waste projects in Curitiba were analyzed according to a protocol developed in the scope of this research. Namely, a public initiative, E-Lixo, and a privately funded, Recicla E-Waste were addressed.

The data gathered shows that the public program considered covers a limited territorial area of the city. These public projects are also being used for raising awareness in how to behave more responsibly towards this waste. The E-Lixo program has a municipal marketing strategy, raising awareness through media and social media channels. Private initiatives do not aim at disseminating knowledge on the subject and are naturally profit-driven. However, they happen more regularly (daily), although also in a limited area of the city.

Overall it is concluded that waste disposal opportunities are still limited for the citizens of Curitiba and its metropolitan area, also in the number of items that can be disposed of at a time. Although the periodicity by which these initiatives happen has seen improvements, it could be further improved by an even more regular organization of disposal events, as well as by the extension to more locations within metropolitan Curitiba and by the introduction of a central e-waste delivery station.

**Author Keywords.** E-waste, Strategies, Public Services, Strategic Digital City.

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## Characterization of Concrete Blocks Commercialized in Montes Claros

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### Abstract

The structural masonry with concrete blocks receive loads from the entire structure and dispense the use of the columns and beams. As the main component of this constructive method, the quality of blocks influences directly the capacity to receive the loads and quality of the building constructed with them during the service life, and execution or maintenance cost. Due to this importance, it's necessary to check the geometry, visual defects, physical and mechanical characteristics of them, to indicate their technical and economic viability. This paper aimed to investigate and characterize the blocks that are sold at the suppliers in Montes Claros – MG, Brazil. In this study, 16 concrete blocks class B were acquired from three different companies, totalizing 48 samples. The block class B is expected to have compressive strength between 4 MPa and 8 MPa, absorption less than 8%, and shrinkage less the 0,065%. Those companies, was called by A, B, and C. All blocks passed by a visual analysis first, then geometric characterization, physical characterization, and mechanical characterization according to ABNT NBR 12118: 2013. During the visual analysis, 4 blocks from each supplier were excluded for presenting cracking or wear that would compromise the test to mechanical characterization. Then, only left 36 blocks (12 of each supplier) for the other tests. Between them, the blocks from supplier C showed more irregularities and had material accumulation at the bottom of the hole of some blocks. For the geometric characterization, the blocks of the A and B companies presented dimensions according to the standard. From the mechanic characterization, all blocks were classified as class B due to their compressive strength. Lastly, in the physical characterization, all elements showed an absorption level lower than that established by the standard. All blocks were according to the standard for physical and mechanical characterization. However, in the visual analysis, many blocks showed cracks and irregularities making it difficult to finish the walls better and influencing structural strength.

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## Uses and benefits of BIM in construction management

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### Abstract

In the past few years, in the AECO (Architecture, Engineering, Construction, Operations) industry it is possible to observe the ineffective planning or missing planning in the project development process is a common problem, which brings on to errors, delays, and undesirable expenses in the budget. It can happen due to the processes is not being well defined, lack of information and definition of the assignment process, or the non-implementation of technological tools to help solve those problems. In this context, the present paper aims to identify the benefits of using Building Information Modelling (BIM) technology in construction management and construction management brings in the stages of a project. The results showed that the knowledge of the process, the standardization of steps, the training of the team, the definition of the level of detail (LOD), and the flow of information are required for 4D planning.

**Author Keywords.** BIM, 4D Planning, Construction Management.

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## Advantages of using of BIM methodology in civil construction

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### Abstract

AECO (Architecture, Engineering, Construction, and Operation) sector evolution requires the introduction of computational technologies that assist in the development of new virtual building processes. In this sense, BIM (Building Information Modeling) technology has been increasingly used as the main tool in the development of building design. This study presents a review of publications on BIM adoption in AECO industry and a simulation of a virtual building model and aimed: showing the benefits of using BIM as a design tool; analysing the virtual simulation according to a defined schedule; evaluating the clashes between the disciplines in a unique model; evaluating the quality of the design and incompatibilities among them; and evaluate the practicality and the automation process. According to the results, BIM facilitates the development of all disciplines, reduces time spent, and detects issues in the design stage.

**Author Keywords.** Technology, Efficiency, Building Information Modeling.

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## A probabilistic view on high speed low cost railway bridges

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### Abstract

The interaction between high speed trains, tracks, infrastructure, and soil forms a complex dynamic system, comprised of variables with different degrees of uncertainty. This work discusses the different factors that contribute to the analysis of high speed railway bridges, focusing on the running safety of short span bridges. On the structural side, a probabilistic methodology to calculate partial safety factors for vertical deck acceleration is presented and compared to the current EN1990-A2 values. On the trains' side, the limits of validity of the load configurations from EN1991-2 are tested for possible new trains in the future. The results suggest the existence of opportunities for refinement of these norms, contributing in turn to more cost-efficient structures.

**Author Keywords.** Structures, Dynamics, High-speed Railways, Probabilistic Analysis, Eurocode

## Optimization of BIM-based Virtual Reality environments: a workflow proposal

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### Abstract

The implementation of pivotal methodologies such as Building Information Modelling (BIM) in the Architecture, Construction, and Operations sector (AECO) draws new opportunities to complement traditional working approaches towards a more technological and collaborative industry.

Still, many stakeholders and industry actors do not possess the necessary skills to operate with BIM models, thus leading to research efforts combining more natural ways of interacting with virtual models. In this regard, Virtual Reality (VR) environments demonstrate several advantages when combined with BIM models, such as the understanding of the overall building space and related construction project specifics otherwise not so easily recognized through non-immersive interfaces. However, developing BIM-based VR environments still faces many hurdles and constraints, particularly when working with process-demanding models (e.g., BIM models holding a vast extent of geometrical elements).

The present paper demonstrates a workflow to improve the development of BIM-based VR environments by addressing current challenges when integrating heavy geometric models into a game engine to achieve a smoother performance and visual quality, thus making them suitable to be used by AECO actors.

Results from a comparative test show that the proposed workflow achieves increased frame-per-second rendering and overall graphics performance. The workflow structure is thoroughly described from grouping and exporting several BIM models from a BIM authoring tool, implementing optimizations within a game engine, and performing virtual walkthroughs.

**Author Keywords.** Building Construction, Building Information Modelling, Virtual Reality, Workflow.



# **Seismic Performance of Multistorey Flat Plate and Framed Structures with Shear Walls**

Serra Danis, Humberto Varum

## **Abstract**

Flat plate structures offer remarkable advantages such as more effective height, more flexibility of architectural design, easier formwork, and shorter constructing time over framed structures. On the other hand, since the absence of beams hinders the seismic performance of the flat plate structures, framed structures are more commonly using in Turkey as an earthquake-prone country, especially at residential buildings. However, with the addition of shear walls, the seismic performance of flat plates can increase remarkably if we consider the lateral load resisting capacity of shear walls due to their high in-plane stiffness. The purpose of this study is to compare G+5 and G+12 storey flat plate and framed structures in low and high seismic zones. Eight building models are analyzed by using SAP2000 V22 software. Turkish Earthquake Building Code 2018 followed during analysis. As a result, base shear forces, periods, lateral displacements, floor accelerations are summarized with diagrams and compared with each other.

**Author Keywords.** Flat Plate, Framed, Turkish Code

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