Civil Engineering
Annual International Congress

Proceeding of Annual International Congress on

Civil Engineering

March 25-26, 2025 Oxford, United Kingdom

Civil Engineering Research Training Center

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Civil Engineering
Annual International Congress

Annual International Congress on

Civil Engineering

March 25-26, 2025

Oxford, United Kingdom

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Integration of UAV and GIS in the Generation and Analysis of Urban Infrastructure

Víctor González-Jaramillo[a,*], Millan Alverca[a]

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Abstract

This study focuses on the application of aerial photogrammetry techniques using drone-acquired data, aimed at generating thematic mapping of urban infrastructure. For this purpose, the DJI Mavic 2 Pro drone was used; flights were conducted at different altitudes (80 and 100 meters) with overlaps between 70% and 80% in an area of approximately 20 hectares, allowing the capture of a high number of high-resolution images (less than 10 cm). These images were processed using Pix4D Mapper software, which, through Structure from Motion (SfM) and Multi-View Stereo (MVS) techniques, generated an orthophoto and a dense point cloud. Subsequently, the data was filtered to discard elements not belonging to the ground, enabling the creation of Digital Elevation Models (DEM) and Surface Models (DSM). The incorporation of control points (GCPs) using GPS-RTK and the use of tools such as QGIS and Fusion software ensured the production of highly precise outputs, including the DEM and DSM models, as evidenced by a very low Root Mean Square Error (RMSE). Based on these models, contour lines and thematic maps were generated, facilitating a detailed analysis of the infrastructure within the study area. The results demonstrate that the use of UAVs in conjunction with photogrammetry techniques is an effective and low-cost alternative to traditional methods, optimizing the update and accuracy of cartography, especially in areas with difficult access.

Keywords: UAV; Photogrammetry; GIS; Digital Elevation Models; Thematic Mapping.

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Evaluation of Mobile Applications for Measuring Operating Speed on Rural Mountainous Roads: The Loja-Catamayo Case, Ecuador

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Abstract

This study evaluates the effectiveness of mobile applications for measuring operating speed on rural mountainous roads, specifically on the Loja-Catamayo route in Ecuador. This road presents topographic characteristics that affect visibility and operating speed, a key indicator for assessing road design consistency. Traditionally, this measurement is conducted using specialized equipment such as the VBOX, whose high cost limits its use in resource-constrained environments. The research proposes the use of mobile applications as more accessible and cost-effective alternatives, comparing their results with those obtained using the VBOX. Two applications were selected: Simple Speedometer (iOS) and GPS Speed (Android). The results showed that both applications provide reliable measurements, with variations of less than 1% compared to specialized equipment. However, altitude was identified as a factor influencing GPS accuracy, especially in mountainous environments. To improve the applications' performance, adjustment equations were developed to reduce the discrepancies detected, achieving acceptable accuracy levels for road safety studies. The study concludes that mobile applications are a valid and cost-effective tool for measuring operating speed, contributing to the design of safe and consistent road infrastructure, particularly in resource-limited contexts. It is recommended to use mid- to high-end devices with high-quality GPS receivers to obtain more precise results.

Keywords: Operating speed; mountain roads; mobile applications.

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The Requirement of Sustainable Construction Management in the Current Times and Its Future Trend

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Abstract

Sustainable practices are important in the area of civil engineering, particularly for the long run. Since, construction management is a major branch of civil engineering, so it's high time to focus on sustainable construction management rather than seeing them separately. In this paper, the concept and requirement of sustainable construction management were focused. The author has studied numerous research papers published in the recent years, to find out the gaps in the recent research. From numerous sources, data was collected in order to perform graphical analysis to further understand the current trend of sustainable construction management. On the basis of the graphical analysis, this paper highlighted the benefits and major challenges in the implementation of sustainable construction management. Then, case of India is also considered in this paper, regarding this matter, while performing graphical analysis.

Keywords: Sustainable Construction Management; Sustainability; Construction Industry; Eco-friendly; Novel Technologies.

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Stormwater management in urban environments: An analysis of alternatives using physical models

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Abstract

Uncontrolled urban growth has intensified soil impermeabilization due to the expansion of infrastructure such as roads, buildings, and parking lots, reducing the infiltration capacity of rainwater. This leads to an increase in surface runoff, accelerating the accumulation of flows in rivers and urban drainage systems, thereby increasing the frequency and intensity of floods. To alleviate the burden on drainage systems, stormwater management alternatives can be implemented, which, when integrated into the urban environment, help reduce surface runoff by enhancing infiltration. In this study, a physical rain-runoff model was used to evaluate the performance of three stormwater management alternatives under design storms with various return periods. The results showed that the efficiency of each alternative varied between a 40% and 100% reduction in the peak flow of the flood hydrograph, with a decrease in runoff time ranging from 10% to 60%. Finally, it was observed that the efficiency of the alternatives declined as storm duration increased.

Keywords: Urban growth; stormwater management alternatives; physical rain-runoff model; floods; urban environment.

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Determination of Seismic Damage for Hill Slope Buildings using Supervised Classification-Machine Learning Algorithms

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Abstract

Seismic damage can lead to severe structural failures like cracks and collapses in buildings. The factors such as regular inspections, strong design and soil stability practices are essential to mitigate the risks of a building due to earthquakes. Emergency preparedness further enhances the resilience of structures against earthquakes. Particularly, seismic damage will be more in hill slope buildings.

Current research focuses on the Seismic damage of hill slope buildings. For the purpose, low-rise and mid-rise buildings have been considered, with variation of slope angle of the buildings. A set of Turkish ground motion records has been applied in the INSPECT tool to estimate the seismic damage. Further, the analysis has been carried out to train the damage values using supervised classification machine learning algorithms.

Keywords: Seismic Damage; Machine Learning; Ground motion parameters.

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Validation of flood routing techniques in an Andean micro-basin

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Abstract

Flood routing methods are generally classified into two categories: hydraulic and hydrological methods. In this study, two hydrological methods (Muskingum and Muskingum–Cunge) and one hydraulic method (Kinematic Wave) were evaluated to model the outlet hydrograph in a section of the main channel of a micro-basin in the equatorial Andes. The evaluation was conducted by comparing the hydrographs measured at the outlet of the section with the inflow hydrograph routed to the outlet. This comparison was performed using three parameters commonly applied in hydrological engineering. Although all three methodologies demonstrated a high level of reliability, the Muskingum–Cunge method exhibited the highest efficiency. Given its computational simplicity and the fact that it requires relatively easy-to-obtain data, it becomes an attractive option for flood routing.

Keywords: Flood routing; Muskingum; Muskingum – Cunge; Kinematic wave.

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Climate-Responsive Ecological Design: Bioclimatic Strategies for Green Building

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Abstract

This article examines the bioclimatic design of high-rise buildings as an efficient approach to integrating local climatic parameters to enhance the energy efficiency and environmental sustainability of contemporary urban development. The study considers major climatic parameters (temperature, humidity, atmospheric pressure, wind speed) alongside minor factors (solar radiation, precipitation, pollution, cloud cover), all of which influence the formation of the built environment's microclimate. The research methodology is based on applying biological principles concerning the equivalence and non-equivalence of climatic factors, enabling the establishment of a hierarchy of parameters and optimising their consideration at the design stage. Particular attention is given to mathematical modelling of variations in temperature, atmospheric pressure, wind speed, and humidity with altitude, substantiated by empirical data and physical laws. The analysis of major and minor climatic parameter interactions illustrates how these processes influence building operational regimes and highlights the necessity of adaptive design solutions. The findings contribute to both theoretical advancements and practical applications in optimising bioclimatic architectural strategies for shaping sustainable and environmentally responsive urban developments.

Keywords: Bioclimatic design; Ecological design; Adaptive solutions of High-rise buildings; Climatic parameters; Sustainable urban development.

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Can ChatGPT-generated exams using Bloom's taxonomy effectively assess cognitive learning outcomes in road engineering education?

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Abstract

This study investigates the effectiveness of ChatGPT-generated multiple-choice exams in evaluating cognitive learning outcomes in civil engineering education, specifically in the subject Road Construction I at Universidad Técnica Particular de Loja, Ecuador. Using the revised Bloom's Taxonomy as a framework, a 32-question exam was developed, covering the first four cognitive levels: remember, understand, apply, and analyze. The test was administered to 101 students divided into two groups, and the results were analyzed based on difficulty and discrimination indices, as well as internal reliability using the KR-20 coefficient. Findings indicate that while ChatGPT-generated questions demonstrated acceptable internal reliability (KR-20 > 0.7) and discrimination indices, but reveal that 40–50% of questions fell outside the optimal difficulty range. Unexpectedly, higher-order cognitive questions yielded better scores, underscoring both the potential and challenges of AI in creating balanced assessment. This study underscores the potential of ChatGPT as a tool for generating assessment instruments but also identifies limitations, particularly in creating balanced difficulty distributions and higher-order cognitive questions.

Keywords: Torrent control; River channeling; HydroVLab; Overflow; Flood control.

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Automation of calculation tools for river channel analysis and design

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Abstract

Rivers are natural channels that drain water from a specific watershed. Sometimes, the flow exceeds the capacity of the existing channel, causing it to overflow and create problems for nearby populations, damaging existing structures or flooding inhabited areas. This has caused thousands of deaths and continues to generate direct economic costs amounting to tens of billions of dollars. Therefore, it is necessary and urgent to address flooding events and develop flood management strategies to reduce adverse consequences and handle more complex types of floods. River channeling and torrent control are essential components of water resource management and natural disaster prevention. River Channeling is a free application developed in Visual Basic .NET within the Microsoft Visual Studio environment, designed to automate the calculation and analysis of river channel design and torrent control, and is implemented in the Virtual Hydrology Laboratory (HydroVLab). This application uses empirical and semi-empirical methods to simulate the behavior of natural channels, considering hydrological and geomorphological variables. It automates the regulated channel process, ensuring its stability, and designs the necessary horizontal and vertical control works. The intuitive interface allows for data entry and results visualization, facilitating the process of analysis, design, and decision-making.

Keywords: Bloom's Taxonomy; Road Design Learning; Cognitive Assessment.

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Evaluation of Mechanical Properties of Clay Adobes Reinforced with Sheep's Wool Fibers for Thermal Insulation Applications

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Abstract

This study analyzes the incorporation of sheep's wool fibers in clay adobes and evaluates their mechanical properties through bending and compression tests. Different optimal proportions of materials were determined, showing that adobes with 1% sheep's wool reached a compressive strength of 2.22 MPa, increasing the resistance by 75% compared to traditional adobes and 28.5% compared to traditional adobes without reinforcement. In addition, the addition of wool improved the energy absorption capacity, increasing the maximum displacement by 67%. These findings suggest that adobes reinforced with sheep's wool can be used in sustainable constructions, optimizing thermal insulation, without significantly compromising mechanical resistance.

Keywords: wool adobes; mechanical properties; flexural strength; compressive strength; sustainable construction.

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Grease trap waste to biogas: A kinetic study of methane yield optimization from anaerobic digestion utilizing acclimated inoculum

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Abstract

Grease trap waste (GTW) is becoming one of the highly explored substrates to produce biogas, as previous studies have shown it lipid content has a high methane production potential. Despite its potential, the interest in GTW mono-digestion has grown making it an attractive option for biogas production. However, the challenge lies in managing the instability of the digestion process, as grease trap waste alone tends to create operational issues such as long-chain fatty acid (LCFAs) accumulation, which can inhibit microbial activities. There are several other methods that can be employed to address the challenges and one of the factors includes inoculum acclimatization, where the microbial community is gradually adapted to high-lipid substrates. Despite the technical advancements made in previous studies, there is limited understanding of how acclimatized inoculum influences reactor kinetics. This study aims to fill this gap by investigating the performance of acclimatized microbial communities in anaerobic reactors labelled as R_{AB}, with a focus on methane production kinetics. Without lag phase, R_{AB} reactor showed the highest methane production performance as compared to $R_{control}$ when methane composition recorded was 71% with 0.455 LCH_4/L.day of methane production rate and 0.22 $LCH_4/gCOD_{removed}$ of methane yield at OLR of 2.2 gCOD/L.day. The experimental results were well fitted in Monod and Contois kinetic models. High relationship between experimental and simulated results were obtained with high correlation coefficients (R^2) ranging from 0.96-0.98. Overall, the efficient strategies to enhance methane productions were evaluated when overall methane enhancement were 42%. Accordingly, the kinetic models used in the study can be used to foresee the performance of the reactor for anaerobic digestion system treating GTW.

Keywords: Grease trap waste; biogas; anaerobic; acclimatized inoculum; kinetic; Monod; Contois.

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Analyzing the land use and land cover changing dynamics in the Myzeqe plain of Albania, using GIS and RS, for the period 1991-2020

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Abstract

The political change (decline of communist regime) that happened in Albania in year 1990, had its impact in the social and economic activities and as a consequence it affected the dynamics of Land Use, especially in the rural settlements, which main economic activity is Agriculture. Myzeqeja Pain, located in the south of Western Lowland region, was also affected by these changes, which are reflected also in its LU/LC patterns.

Main objective of this study is to detect and analyze the changes' dynamics in Land Use and Land Cover of the Myzeqeja Plain over a period of time and also to determine its current status by using GIS/RS. It also focuses on the impact of human and natural factors in these dynamics and patterns. The database of Copernicus satellite products is widely used in the field of earth sciences for the analysis of various geographical and geostatistical indicators. The processing of this database, through GIS techniques, brings a set of scientific results on the changes undergone and the current state of land use and cover in the Myzeqe Plain.

This paper has a new approach to land dynamics in the Myzeqe Plain, creating a new database ready to be used in various studies, as well in preparing for future challenges or drafting the strategic management plans. Such analyses guide us towards accurate results, determining the prognosis and formulating real suggestions to improve the future Land Use and Land Cover dynamics of the studied areas.

Keywords: Myzeqeja Plain, Land Use and Land Cover, Remote Sensing, Geographic Information Systems, Changing Dynamics.

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Evaluation of the Environmental Impact of Traffic Congestion using Remote Sensing: Bab Al-Muadham Zone as a Case Study

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Abstract

In general, Baghdad city suffers from a principal problem which is traffic congestion. It has affected it in particular environmentally, healthily, urban and economically due to many reasons. Some of these reasons are the increase in urban growth of the population and the increase in the number of vehicles in it as a reality to meet the requirements of citizens. However, this growth was not accompanied by any development or modernization in the fact of the current road network, which led to an increase in the volumes of traffic flows for the roads. Consequently, the inability of these roads to meet the level of service for which they were designed to ensure the flow of traffic, thus leaving stifling traffic congestion. Bab Al-Muadham area was chosen as a case study because it suffered for many years from traffic congestion that affected its environmental reality. In this research, the factors causing traffic congestion and the resulting damages are addressed in order to lay hands on effective ways to solve this crisis. Field surveys and statistical studies were conducted to assess the real road performance relative to the actual traffic momentum. The amount of pollutant concentrations in the study area was measured using electronic sensors to assess its environmental and health conditions. Results obtained from empirical data were analyzed and discussed. The suggested solution also had a share in this study to address this region's real problem.

Keywords: Environmental impact; Pollution; Remote sensing; Traffic congestion; Traffic flow.

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Pathologies of reinforced concrete buildings in Morocco

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Abstract

At present, the reinforced concrete buildings are most widespread in Morocco, these buildings suffer over time from degradation that must be repaired to extend their lifespan and operate them in conditions of safety and comfort, hence the importance of this subject of this communication.

The work methodology adopted to study the pathologies is based on the data available in different scientific sources such as these, scientific articles, etc. This methodology comprises three phases:

1) Identification of the damage.
2) Diagnosis and determination of the causes and origins of this damage.
3) Choice of the appropriate treatment to remedy it.

According to the research carried out, the pathological symptoms are multiple, the causes and origins are also multiple. These are often linked to foundation soil movement, structural design defects, building waterproofing, construction work execution defects, construction material failure, building's maintenance method, modifications made in the building, climate, or to disasters such as fire, explosion, earthquake, flood or violent windstorm. The treatment of the damage encountered varies from one building to another according to its nature and its importance. There are several techniques tested in the field to remedy it.

Keywords: Cracks; Corrosion; Carbonation; Jacketing; FRP composite material.

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Improvement of the Mechanical Properties of Cement Mortar by the addition of Silica Nanoparticles

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Abstract

This work aims to show the effect of the introduction of silica (SiO_2) nanoparticles on the stability, structural and mechanical properties of cement mortar. The samples obtained after the incorporation of silica were characterized by MEB, DTG, GTA and DSC. The mechanical properties of these materials were also evaluated. The results indicate that cement mortar's mechanical performance was greatly improved when silica nanoparticles were added. In this case, the values obtained show that the introduction of the SiO_2 nanoparticles into the cement mortar has greatly improved their compressive strength, and the increase is of 36.5 % after 28 days, suggesting that the addition of SiO_2 nanoparticles in the cement mortar is a suitable way to enhance their mechanical performances. Moreover, the results indicate that the suitable percentage for improving physical durability and mechanical properties is around 1.5wt% SiO_2. Also, the results show that the flexural strength of the cement mortar has been greatly enhanced with the introduction of silica nanoparticles.

Keywords: Cement mortar; SiO_2 nanoparticles; Workability; Compressive and flexural strengths.

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Small-size Effect on the Critical Buckling Response of Single Layered Graphene Sheet Nanoplates via NSGT and New HSDT

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Abstract

This study proposes a new hyperbolic shear deformation plate theory (HSDT) considering the non-local and length-scale parameters via nonlocal strain gradient theory (NSGT). This formulation considers the small-scale and microstructure effects, which becomes important at micro- and/or nano-scales to analyze the buckling of single-layered graphene sheets (SLGS) nanoplates resting on Kerr/ Pasternak /Winkler foundations. The number of unknowns in this theory is only four (04) and does not require a shear correction coefficient which satisfies the condition of zero shear stresses at the top and bottom surfaces of the nanoplate. The equations of motion are derived from Hamilton's principle. Afterward, they are solved analytically using the Galerkin method leading to the effect of various boundary conditions. To demonstrate the effectiveness and validity of this approach, the results obtained from the present HSDT are compared to other plate theories in the literature. Subsequently, the present model is exploited to highlight the impact of non-local and length-scale parameters on the critical buckling load of SLGS. The influences of several parameters on the critical buckling of SLGS are also investigated. It appears that the nonlocal strain gradient model in conjunction with the present new HSDT which contains only four unknown variables against five or more in the other higher-order theories is simple and can be utilized with confidence to model and benchmark the nonlocal and length-scale effects for the critical buckling of SLGS.

Keywords: Single-layered graphene sheets; Orthotropic plates; Hyperbolic shear deformation plate theory; Buckling; Kerr/ Pasternak /Winkler foundations.

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Investigation of wind impact on natural ventilation in housing: addressing the challenges of thermal renovation

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Abstract

This paper presents findings from experimental research on the surface pressure coefficient distribution across the roof of a 5-story residential building, using a model of an actual building in Lviv, Ukraine. The model is based on a wind tunnel that simulates wind forces on residential buildings. The experimental results show that the wind-induced pressure on the roof surface of the building is significantly higher than that of the surrounding buildings, resulting in the accumulation of hazardous concentrations of harmful substances within the building. These findings are highly pertinent for formulating recommendations for the efficient operation of passive ventilation systems in existing buildings within densely constructed urban areas, thereby improving energy efficiency, indoor air quality, and reducing carbon emissions. This approach is crucial for enhancing the design methodology of new buildings and thermal retrofitting of existing ones, particularly focusing on optimizing natural ventilation in medium-rise buildings in densely populated urban areas.

Keywords: natural ventilation; surface pressure field; indoor air quality; thermal retrofitting; CO_2 emmision.

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The energy efficiency of an Adobe earth building: A comparative analysis of two different construction methods in arid climates

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Abstract

The construction industry poses significant challenges in terms of global energy consumption and greenhouse gas emissions, raising critical concerns for environmental sustainability. In arid climates, these issues are amplified by extreme temperature fluctuations, making energy-efficient building designs an essential focus of scientific research. This study investigates the potential of using earth-based adobe bricks, a traditional and sustainable building material, to enhance energy efficiency in such climates. Specifically, it compares two construction techniques: the traditional single-wall method and an alternative double-wall approach. Dynamic thermal simulations were conducted using TRNSYS software to evaluate the energy performance of both methods. The results demonstrate the superior energy performance of the double-wall technique, which significantly reduces energy consumption compared to the single-wall method. This reduction is attributed to improved thermal resistance and the insulating properties of the air gaps. The findings emphasize the importance of optimizing building envelope designs in arid climates, where substantial cooling and heating demands drive high energy consumption. This study underscores that integrating sustainable materials, such as adobe bricks, with innovative design strategies offers an environmentally friendly and energy-efficient alternative to conventional construction practices.

Keywords: adobe bricks; energy efficiency; ecological buildings; sustainable materials; thermal simulation.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

User Willingness-to-Pay on The High-Speed Rail (HSR) Fare Charges

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Abstract

High-Speed Rail (HSR) is one of the rail modes of public transport that is growing rapidly and has been used widely throughout the world. HSR travels more than 200 km/h every trip, which is faster than conventional trains. With shorter travel distances and more trips per day, HSR enables shorter journeys than conventional trains. Given the increased speed and shorter journey time, the current fare charges for High-Speed Rail (HSR) services are more expensive than the fare charges for regular train services. The purpose of this study is to examine the factors that affect user's willingness to pay for HSR fare charges and to conduct a model shift analysis. To evaluate users' willingness to use the HSR transport system using the modal shift method and Binary Logistic regression analysis, a questionnaire survey was carried out. To collect data, 200 questionnaires were randomly handed out to respondents in the Kluang area. All the factors were positively significant, according to the binary logistic regression analysis. Different points of view determine the factors that affect respondent's decision-making process and to use the HSR services. Among the factors affecting a public vehicle's dependability are the frequency of the trip and the punctuality of vehicles arriving and departing. From the modal shift method analysis results, users shift from choosing to use HSR transport to airline due to the increasing of fare charges starting at price range RM100 – RM200 and shift from choosing HSR to airline when the increasing of time travel occurs start at 2 to 3 hours range of time.

Keywords: High-Speed Rail; Fare Charges; Modal Shift Method.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Industrial pollution of the Hassi R'mel gas field - Algeria, consequence of the improbable city-industry cohabitation

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Abstract

This article seeks to address the issue of environmental fallout from high-risk gas industries in the town of Hassi R'mel in Algeria. It focuses on the observation and assessment of pollution risks on the urban perimeter cohabiting with factories. Due to their locations in vaste desert expanses, the ecological dimension of these industrial concentrations of Hassi R'mel is relatively neglected. From the 2000s, the increase in export levels necessitated an accelerated production rate of natural gas, Over the years the impact of the hydrocarbon industry on the natural ecosystem took worrying dimensions of which the complex Hassi R'mel gas company which represents a significant case. In this paper, we would like to present the situation of air and soil pollution that has caused serious consequences on the natural ecosystem surrounding the industrial city of Hassi R'mel. An empirical approach was carried out based on field work, official statistics, reading of the various town planning instruments, the environmental audit report and Hazard Study Report, questionnaires and semi-structured interviews with residents and local public actors. The results obtained from the analysis of these data show a potential risk of pollution over the vast expanse of the outskirts near the city of Hassi R'mel, threatening the population and the natural ecosystem.

Keywords: Hassi R'mel gas field; city-industry cohabitation; hydrocarbons; air pollution; soil pollution; natural ecosystem.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Evaluation of Concrete Mixed Using IS 10262:2019 for Recycled Coarse Aggregate in Sustainable Concrete Applications

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Abstract

This study evaluates the mix design of concrete incorporating Recycled Coarse Aggregate (RCA) following the guidelines outlined in IS 10262:2019, which encourages RCA usage in construction without providing specific directions for its integration. The focus is on defining the concrete grade when RCA is used, such as M20, M25, or M30, which conventionally indicates compressive strength after 28 days for fresh materials. However, a distinct grade identifier, like M25*, should denote RCA utilization in concrete, addressing the lack of such guidelines in the current code. Additionally, the study examines target strength provisions and the appropriate water-cement (w/c) ratio, given that RCA typically absorbs more water than virgin aggregates. A proposed modification to the w/c ratio, ideally between 0.4 and 0.45, accounts for RCA's water absorption characteristics. Further, adjustments in water content based on aggregate size are also suggested to meet performance standards. These modifications suggested with the example of mix design. The main aim to enhance the usability of RCA in sustainable construction by providing practitioners with clearer guidelines for mix design, ultimately supporting the construction industry's shift toward eco-friendly practices.

Keywords: Recycled aggregate; Grdae of concrete; IS code guidline of Concrete mix design; w/c ratio; sustainable material.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Innovative approaches to urban waste facility placement: integrating predictive modeling into Construction and Municipal Services

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Abstract

This paper explores the use of advanced predictive methodologies to enhance municipal solid waste (MSW) management within the domains of urban construction and municipal services. By employing artificial neural networks (ANNs), adaptive neuro-fuzzy inference systems (ANFIS), and correlation-regression analysis, the study develops a comprehensive framework for forecasting waste generation and morphology. The findings highlight critical socio-economic and environmental factors influencing waste production, providing actionable insights for optimizing waste facility placement and operations. The research categorizes existing forecasting methodologies into four primary groups—time series methods, deterministic and stochastic models, GIS cluster analysis, and statistical learning theory techniques. It evaluates their advantages and limitations, with a focus on their applicability to urban planning challenges. Among these, statistical learning methods, particularly ANNs, demonstrated superior accuracy and adaptability in modeling non-linear relationships and predicting waste dynamics in complex urban environments. The proposed approach integrates predictive analytics into urban planning, emphasizing accessibility, cost-efficiency, and minimal environmental impact. It leverages GIS-based spatial data and behavioral analytics to refine facility placement strategies and improve waste collection efficiency. Furthermore, the study underscores the importance of addressing long-term sustainability goals through data-driven decision-making. This work contributes to the advancement of circular economy principles by supporting resource recovery, reducing landfill reliance, and aligning waste management with broader urban sustainability initiatives. The practical applications of this research include dynamic scheduling for waste collection, enhanced recycling programs, and the strategic integration of waste facilities into urban infrastructure. By adopting these methodologies, urban planners and municipal authorities can achieve significant improvements in operational efficiency and environmental performance, paving the way for more resilient and sustainable waste management systems

Keywords: Municipal solid waste; predictive modeling; artificial neural networks; urban construction; waste facility optimization; municipal services; circular economy.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Effects of Inflation on the Procurement of Construction Materials and Quality Delivery of Public Building Projects in Nigeria

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Abstract

Globally, the influence of the inflationary tendency poses significant challenges that affect the entire performance of all sectors of the economy, including project delivery in the construction industry. In Nigeria, the astronomical increase in inflation rate has had a significant impact on construction material costs, which have increased to more than 80%. This has resulted in thousands of abandoned projects across the country and has become a major impediment to quality project delivery. Apart from their far-reaching effect on the internal dynamics of the construction sector, inflation rates might also be evaluated in terms of how they affect project key success factors, such as cost, time, and project quality. This study aims to investigate the influence of inflation on construction material procurement and public project delivery in Nigeria's construction industry. The objective is to identify strategies for improving construction project procurement and delivery. A quantitative approach was adopted for data collection. Through a questionnaire survey, a hundred and five (N = 105) questionnaires were distributed to architects, builders, contractors, developers, engineers, and quantity surveyors. The findings brought to the fore influencing factors such as local sourcing, collaborative partnerships, value engineering, and technology adoption as areas where construction practitioners should focus more attention in order to minimize the identified effects of inflation on construction material procurement and project delivery. The paper recommended that digital procurement platforms and/or supply chain management systems be prioritized and used in order to optimize inventory management, uncover cost-saving opportunities, and streamline procurement processes. This could offset the effects of acknowledged inflation on building material procurement, allowing for more effective and timelier project delivery.

Keywords: Construction Materials; Inflation; Procurement; Project Delivery; Nigeria.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Properties of Optimized Cementitious Composites Incorporate Precipitated $CaCO_3$ Particles

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Abstract

Calcium carbonate and its derivatives are used broadly in the cement and construction industry. It hereby provides a reasonable and active solution for reducing the earth's carbon footprint. In the current work precipitated $CaCO_3$ (PCC) particles are prepared by precipitation technique, characterized, and added to cement at different concentrations (0.076-0.92) wt. % of cement, and w/c ratio: 0.36-0.50. The fresh cement composites were tested for setting time and temperature rise during the early hydration stage, and the hardened composites for compressive strength, density, and water absorption. The results obtained showed that at a constant w/c ratio increasing the content of the PCC up to 0.25 leads to an increase in the initial setting time, density, and compressive strength. However, more PCC content has negative effects on the properties. Increasing the w/c ratio increased the setting time and water absorption of the composites. Low concentrations of PCC lead to a decrease in the tendency of water absorption, while high concentrations showed diverse effects. At a constant w/c ratio, samples with PCC content (0.92 and 0.076 wt. %) showed temperature rising at about 25 and 75 minutes respectively after batching, while the control samples showed the temperature rising at about 105 minutes. The observations confirmed that the hydration reaction of both the control and cement composite samples incorporated with PCC are exothermic, and the PCC particles have a positive impact on the hydration rate. Overall, the incorporation of PCC in cement at appropriate concentration and w/c ratio contributes to obtaining strong and durable cement composite for structural applications.

Keywords: Precipitated Calcium Carbonate (PCC); Cement composites; Setting time; Temperature rise; Compressive strength.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Evaluation of Rubberized Concrete Properties: Compressive strength, splitting tensile strength and Density

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Abstract

The growing environmental demand to reduce both natural resources depletion and industrial waste generation has sparked an increasing interest in sustainable construction materials. Among these, green concrete presents a promising solution. Thus, using rubber grains from end-of-life tires is a viable alternative for producing green concrete. To contribute in research advancement on this innovative concrete and based on numerous studies results, compression and splitting tensile tests and density measurements were realized at Gheorge Asachi Technical University of Iasi in Romania. The materials used in this investigation were mainly, CEM II/B-M (S-LL) 42.5R cement from Holcim, natural aggregate classified into 3 size groups: 0-4mm, 4-8mm, 8-16mm, and rubber crumbs obtained from discarded tires sorted into 2 size ranges; 0-4mm and 4-8mm. Tap water was used for this research.

Keywords: Rubber; concrete; compression strength; splitting tensile strength; density.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Development of a microsimulation model for predicting a driver decision within the dilemma zone at signalised intersections

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Abstract

Dilemma zone (DZ) is a challenging area where drivers have uncertain decisions whether stopping or proceeding is safer as the traffic light changes. Artificial intelligence (AI) has been explored for improving autonomous vehicles (AVs) performance in terms of sensors such as cameras and radar. However, there is a need for a vast data to enhance vehicle's responsiveness with its environment accurately. In this paper, a microsimulation model was developed, calibrated and validated to represent driver decision while approaching a traffic-controlled junction as the signal light turns from green to amber then red. The research methodology considered car-following algorithms with modified steps. Wide range data were modelled including drivers' time responses, junction geometry, vehicle characteristics and signal timing setting. The developed algorithm codes were written by FORTRAN-95 language. The newly simulation model showed good representation of observed red-light running behaviour by 98%. Also, various scenarios were implemented to investigate the effect of amber length on drivers' compliance. It can be highlighted that increasing amber length by 1 sec extra might rise the number of signal violations by 33%. Moreover, safety aspect in terms of close-following behaviour was tested in the newly model. The outputs showed that 10% of simulated following behaviour were experienced lower than 2 sec distance between successive vehicles which is a reflection of risky tailgating behaviour and might lead to involve in potential conflicts after the signal change. It can be concluded that the newly developed model is a promising technique for enhancing the car-following algorithms and making-decision of AVs effectively.

Keywords: Driver decision; Car-following model; Signalised intersection; Signal violations; Dilemma zone.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Implementing professional Project Management according to the (PMI) with Building Information Modeling (BIM) as a solution to solve Project delays in Iraq

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Abstract

The study focused on a real project that was implemented using the local system in the scientific departments building of the Technical Engineering College in Iraq - Maysan. In this study, the success of BIM technology in adopting building information was evaluated by comparing the local system in Iraq with the global system according to PMI. Multiple programs were utilized to elucidate the dimensions of BIM and integrate them with the system. Global professional project management, where Autodesk AutoCAD 2023 was utilized as the application, according to BIM To see the building's 2D dimensions before using the application Revit 2023 for Autodesk To display the third dimension in three dimensions; count quantities and eliminate interferences and errors that are anticipated to arise during implementation; lessen errors that arise when counting quantities conventionally; cut down on spare orders; and shorten the time required to approve change orders. We were also shown the dimension using the Primavera p6 20.12.0 application. In order to minimize the evidence for the fourth 4D it is necessary to link the ideal values taken from Revit with the precise computation of the time period with the schedule. depending on BIM technology and finishing the project within a standard period as per the worldwide system, as opposed to an ideal time plan that was implemented in the global system as per PMI, with the project timeline differing. Genuine, on-the-ground execution the different rate for Primavera P6 20.12.0 planning was (300 %). Additionally, the difference in prices between the project's actual cost and the cost estimated using Rivet was 15.5 %. As well as the difference between the cost of the original project and spare parts compared to the cost calculated from the Revit program was (6.5%). This difference in prices and quantities were retrieved using the Microsoft Excel application, and it was discovered to vary between (-71 % to +64.5 %).

Keywords: Project Management Institute (PMI); Project Management Professional (PMP); Building Information Moduling (BIM); Planning & Scheduling.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Campus Mobility Enhancement Through Carpooling System Design and Route Analysis in Loja-Ecuador

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Abstract

This research evaluates the implementation potential of a carpooling system for teaching and administrative staff at the Universidad Técnica Particular de Loja (UTPL) in Ecuador. The study focuses on optimizing daily commutes in a medium-sized city environment where travel distances average 2.5 kilometers and rarely exceed 8 kilometers. Using ArcGIS's Survey123 for georeferenced data collection, ArcGIS Pro and ArcGIS Online for travel time calculations, the research assessed staff preferences regarding carpooling adoption, vehicle availability, seat capacity, and compensation structures. Results demonstrate an 18.7% reduction in total kilometers traveled and a 20.2% decrease in overall travel time through strategic route optimization. The proposed carpooling system would reduce campus-bound vehicles by 26%, increasing average vehicle occupancy to 2.92 passengers. The implementation strategy incorporates proximity-based route analysis, considering both drivers' availability and users' locations. The findings suggest significant potential benefits in reducing traffic congestion at university access points, optimizing parking space utilization, and decreasing the urban vehicle footprint. Financial analysis indicates user preference for compensation rates between 0.25-0.50 USD per trip, with 89.7% of respondents expressing willingness to participate in the system.

Keywords: Carpooling; Sustainable; mobility; transportation; optimization.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Olive solid waste-based concrete

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Abstract

Agricultural waste has gained increasing potential for use in various civil engineering applications such as mortar, concrete, and additives, due to its abundance, recyclability, and promising environmental and energy-saving benefits. Our innovative green concrete material, based on Olive Solid Waste (OSW), contributes to these efforts and aligns with European initiatives promoting the integration of biosourced materials in the construction of both new and renovated buildings. This study explores various treatment methods for waterproofing OSW to make a treated biosourced Olive Solid Waste Concrete (OSWC). Additionally, it evaluates the material's mechanical and thermal properties, with the aim of using it in the manufacture of bricks or insulating panels.

Keywords: olive solid waste, treatment, Innovative concrete, biosourced.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Earthquake-resistant reinforced concrete frame of single-storey buildings

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Abstract

The article presents the results of complex experimental studies of seismic resistance of one-storey reinforced concrete frames with developed hinge nodes of connection of cover structures with columns, as well as individual hinge nodes, under seismic-type loads. In contrast to typical nodes, the use of hinge nodes in the design will ensure compliance of the design scheme with the real structural scheme, increase the dissipative properties of the frame during vibrations, due to energy dissipation in the hinge joints and save steel by eliminating the device of metal links in the cover structures, necessary for typical nodes. There is a copyright certificate for the invention (A.S.№1256222). There have been developed recommendations on calculation and design with an example of calculation.

Keywords: Earthquake; reinforced concrete.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Study of the fractal dimension of grains under the effect of cyclic loading

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Abstract

Soil grains, in nature, can form truly complex and irregular configurations that are generally extremely difficult to characterize geometrically. However, certain mechanical properties can be controlled by studying dimension, shape, angularity and roughness of the grains. Euclidean geometry appears insufficient and is not suitable for representing all the details of natural objects such as soil grains. It becomes essential to study the irregularities of their shapes to understand them further. It is then necessary to characterize it using the new theory called "Fractal", which offers us several methods of calculating the fractal dimension, which is a characteristic that designates the degree of irregularity and fragmentation of a grain, such as the box counting method, the surface-perimeter method, etc. This work proposes the calculation of the fractal dimension of the grains of a local material before and after crushing under the effect of cyclic loadings in the oedometric test in the laboratory. The variation of the fractal dimension calculated before and after the loading cycles, corresponding to the crushing effects of the grains, is strongly influenced by the shape, size, granulometric distribution of these grains and by the effect of the number of loading-unloading cycles. Which confirms the interest of calculating the fractal dimension at the scale of a grain or at the scale of a sample and its usefulness for understanding and studying the mechanical behavior of granular materials in the field of civil engineering in general.

Keywords: Soil grains; shape and roughness of grains; crushing, cyclic loadings; fractal dimension.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Influence of fracturing on slope stability

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Abstract

Based on geological investigations of the ground, the deposit is known to exhibit natural fracturing. The stratification layer in this one is sheared by families of diaclases with widely distributed orientations and rough discontinuity joints. In addition to the length and kind of filling, the orientation of the front of a bench's fracture affects its stability condition by altering the dip with respect to the operation's direction. Situated within a severely fragmented rock mass, the M'HAOUDATT pit has stability issues that impact the mine's strip ratio and production chain. The structural evaluation of the proposed pit was based on the data collected during the site visit and the mine design criteria defined by the mining engineers. A kinematic stability analysis to define the potential failure mechanisms was done based on the preliminary sectors and the discontinuity data collected during the pit visit. The failure to identify discontinuities (diaclases, faults, stratification planes, schistosity, etc.) that are observed in the field leads to instability issues. The benefits of using seismic geophysical techniques for slope stability evaluations are examined. Because the measurements rely on mechanical parameters that are also crucial in the mechanical computation of slope stability studies, they are frequently the most appropriate. In order to highlight the impact of fracturing on the condition of the deposit and offer methods to restore the normalized strip-ratio of an open pit, this article attempts to ascertain the orientation (dip and dip direction) of each sector of the existing pit.

Keywords: M'HAOUDATT; Hematite; Slope stability; Geophysics; seismic; discontinuity families; Open pit; Banded Iron formation (BIF).

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Suspended arch bridge in Albania: structural monitoring aimed at controlling modal parameters and maximum dynamic stresses

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Abstract

Last summer, the construction of a large bridge in Kukes, Albania, the largest in the Balkans, was completed. Its overall length is 300 m and it consists of a chain girder supported by a tubular arch, with double termination on each side, by means of 98 tie rods on each side. At the same time as its termination, an impressive monitoring system consisting of triaxial accelerometers, optical strands, temperature and wind transducers was installed. At the moment, the system is perfectly functional and is measuring the kinematic and deformation parameters, allowing periodic modal analyses aimed at evaluating the maintenance of the natural vibration frequency. Considering that the preventive investigations in the wind tunnel have highlighted its strong vulnerability in terms of excessive displacements in the vertical direction with lateral actions of medium entity, quite frequent on the site in question, particular attention has been paid to this topic. In this sense, ad hoc algorithms have been implemented that have allowed the values of the dynamic displacements to be obtained by double numerical integration, to be kept under control, starting from the measured accelerations. The operation, apparently simple to say, involved a considerable computational effort, due to the inevitable intrinsic noise of the instrumentation used and the very low frequencies involved. Laboratory tests allowed us to validate the quality and reliability of the adopted methodology which ultimately allowed us to avoid the use of expensive tuned mass damping systems.

Keywords: Operational Modal Analysis; Tuned Mass Dumpers; Structural Health Monitoring; Dynamic Monitoring.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Elastic and Plastic Analysis of Reinforced Concrete Beams: An Example-Based Approach

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Abstract

Reinforced concrete (RC) structures are widely used in construction due to their strength, durability, and adaptability. This paper presents an example-driven approach to analyzing RC beams through both elastic and plastic methodologies. In the elastic analysis, the concrete is assumed to have no tensile strength, and the cross section is treated as homogeneous. The procedure involves locating the neutral axis, calculating the transformed cross-section's moment of inertia, and determining stress distributions in both the concrete and reinforcement. The plastic analysis extends this understanding by incorporating assumptions of yielding stress blocks and force equilibrium to calculate the depth of the compressed concrete zone and the bending moment capacity of the fully yielded section. This study aims to provide a clear and practical framework for analyzing RC beams in structural applications.

Keywords: Reinforced Concrete Beams; Elastic Analysis; Plastic Analysis; Bending Moment Capacity; Stress Distribution.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Manufacturing of Concretes from Lateritic Duricrusts and Nodules and Evaluation of Their Physico-Mechanical Properties

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Abstract

The use of laterites in civil construction for decades in the intertropical area has mainly concerned the construction, maintenance and rehabilitation of roads and, rarely, for the fabrication of concrete. The confection of two concretes based on lateritic duricrusts and nodules following the Dreux Gorisse method, and the evaluation of their physico-mechanical properties was carried out. The cement used is CEM II 32.5R. The results show that the duricrusts have nodular and alveolar facies, made up of quartz grains, nodules and termite galleries. The nodules have rounded to angular shapes, with a reddish to yellowish color, and are composed of goethite, hematite and quartz. The lateritic duricrusts and nodules are classified as 5/25 and 2/25 respectively. Duricrusts are less plastic and denser (PI mean = 16.93%; γs = 3.01 g/cm3) than lateritic nodules (PI mean = 22.93%; γs = 2.88 g/cm3). Lateritic duricrusts have higher wear resistance (Micro Deval (MDV) = 48%) than lateritic nodules (MDV = 32%). The sands are classified as 0/5. These are very clean materials (Sand equivalent (SE) = 97.78%) with low density values (γs = 1.32 g/cm3). The formulations adopted for the duricrusts concretes are 202.92 L of sand, 1236.249 L of duricrusts, 191.1 L of water and 644.66 L of cement (cement dosed at 415 Kg/m3). For the nodules concretes, the proportions are as follows: 618.08 L of nodules; 68.67 L of sand; 104.75 L of cement is 191.1 L of water. The compressive strengths evolve in a sawtooth pattern depending on the curing time for all the manufactured concretes. The maximum average values are 27.13 and 20.95 MPa at 7 days, while the minimum average values are 23.26 and 15.61 MPa at 28 and 1 days, respectively, for duricrust and nodule concretes.

Keywords: Concrete; Dreux Gorisse method; Lateritic materials; Physico-mechanical properties; Center Cameroon.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Modification of the Porous Structure of Cement Stone

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Abstract

The study examines the impact of various chemical admixtures on the formation and development of the porous structure of cement stone. It has been shown that the pore formation process in cement stone differs significantly from that of monomineral binders due to the complex interaction between hydrosilicate and hydrosulfoaluminate structures. Adjusting the distribution of micropores in the range of 2–100 nm can significantly affect the material's properties, allowing for targeted control over the structure during the hardening phase. The research focuses on the role of chemical admixtures in managing cement stone microporosity. The influence of surfactants (lignosulfonates, polymethylene naphthalene sulfonates, and polycarboxylates) and hardening accelerators (potassium and sodium carbonates, chlorides, and sulfates) on pore size distribution and total pore volume during the hydration of Portland cement, slag Portland cement, and high-alumina cement samples was experimentally studied. The findings demonstrate that introducing surfactants effectively regulates the porous structure of cement stone. It was established that modifying the microstructure with surfactants reduces the total pore volume without significantly altering their size distribution. The mechanism of surfactant action involves adsorption on the surfaces of cement grains and new formations, which affects the kinetics of hydration and the structure of the resulting hydrate phases. An analysis of the effects of complex admixtures containing hardening accelerators and plasticizers revealed a more complex influence on the porous structure of cement stone, determined by the combination of various mechanisms. To evaluate the effectiveness of cement stone structure modification, the ratio between the volumes of gel and capillary pores is proposed as an efficiency coefficient (K_{eff}). For example, the combination of polymethylene naphthalene sulfonates with potassium carbonate proved to be the most effective complex admixture for Portland cement. The results highlight the potential for optimizing concrete properties through targeted changes to the microporosity parameters using chemical admixtures. Understanding the effects of these admixtures on microporosity provides a pathway for creating cement materials with tailored properties and optimizing concrete compositions to meet specific technical requirements.

Keywords: cement stone; porous structure; thermoporometry; chemical admixtures; surfactants; hydration; microporosity.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Pre-requisites for a successful Construction and Demolition waste management and the CDW market characteristics

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Abstract

Construction and Demolition waste is the largest waste stream in the European Union, accounting for 35% of total waste in EU, and one of the largest in the world, with an increasing tendency. Some of the common building materials have a relatively high re-use and recycling potential due to technological progress. The environmental importance of C&D waste management is well documented to date in terms of directives and strategic action plans, regulations and standards. C&D waste management is part of the efforts towards climate change mitigation, environmental pollution of land and a measure against the depletion of natural resources. The EU Waste Framework Directive was introduced in 2008 and incorporated into the Circular Economy Action Plan in 2015. C&D waste management is already being implemented around the globe. However, progress differs greatly between countries. Apart from the profound environmental benefits, a new market has emerged, that has already reached US$ 221.38 billion in 2024, with a forecast to reach US$ 308.5 billion by 2030. Successful management relies on clearly identified processes and the ability of all the involved parties to achieve them. The diversity of the involved parties consists of engineers, planners, national and local authorities, stakeholders, the industry and the public, resulting in complexity of implementation. The lack of economic incentives for stakeholders and the low trust of the public in the reused or recycled materials compared to virgin ones, are the most common issues. Other obstacles include the lack of harmonization of policies and mandatory enforcement. Initial design based on the circular build environment concept as well as pre-demolition audits are crucial procedures for successful CDW management on a global scale, providing the optimum reuse and recycling of reclaimed materials from demolition of existing structures and the ability to deconstruct instead of demolishing.

Keywords: CDW management and market; Waste hierarchy; Deconstruction; pre-demolition audits; Circular building environment.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Optimising Freight Forwarding in Road Transport through Machine Learning-Based Price Prediction

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Abstract

The article explores the challenge of automated freight pricing in road transport. The authors, affiliated with a logistics company, aim to develop an intelligent system capable of accurately predicting transport prices. This issue is particularly significant, as millions of transports offers enter the market daily without listed prices, requiring extensive human intervention—such as phone calls, emails, and negotiations. These additional tasks generate unnecessary costs for logistics and transport companies. Furthermore, a human freight forwarder can only evaluate a limited number of offers in a given time frame, which can lead to the omission of potentially profitable opportunities. To address this challenge, the authors employ a Design Science Research approach to create a solution based on Machine Learning algorithms. The outcome of their research is an innovative IT system that provides freight forwarders with real-time predictions of transport prices. The primary objective is to estimate prices for all transport offers available in the market, enabling freight forwarders to identify the most lucrative options swiftly. This system alleviates the burden on employees, eliminating the need for manual searches, client outreach, price negotiations, and margin calculations. On a broader scale, the proposed solution aims to optimise freight transport, thereby reducing overall product costs for customers. Currently, this solution is being integrated into the company's transport management system and is undergoing testing and validation in a real-world operational environment, yielding promising preliminary results. This advancement represents a significant step toward enhancing efficiency in the logistics industry in accordance with current trends observed on the market.

Keywords: machine learning; freight automation; logistics optimisation.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Differential shrinkage as a factor detrimentally influencing interface shear strength prediction for shallow toppings cast on precast hollow core slabs

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Abstract

Interface shear strength characterization in concrete-to-concrete junctions remains a lively matter of study. This is because it is a complex phenomenon involving many factors. The elusive nature of this subject, and its current description in most codes, may hamper proper and secure design in certain situations in jobs of actual buildings. Most current codes focus on the influence of friction-interlock and cohesion-adhesion bonding. Both factors are characterized and mainly governed by subtle geometry alterations of the interface (roughness), and forces applied perpendicular to the interface surface. These two main factors (subtle surface geometry and transverse force) may govern the interface shear strength under specific design conditions where differential shrinkage does not affect cohesion-adhesion. However, certain actual design situations exist, such as composite toppings on precast units (hollow core slabs) or concrete repair overlays applied on old concretes, where differential shrinkage should not be disregarded. In the case of precast floors, realistically addressing this matter could lead to advantageous designs, such as toppings including negative-resisting reinforcement, which is a very efficient way to build cheaper and more sustainable floors using less concrete and steel. The current paper summarizes the results of two laboratory tests campaigns in which differential shrinkage was found to be relevant to interface shear strength when the interface surface relied on slight geometry alterations (roughness). In contrast, it wasn't significant for keyed interfaces where the depth of the keys was at least the size of the course aggregate. Thus, it is suggested that designers should be informed under which conditions the effect of differential shrinkage could be neglected. The codes should warn designers against relying on slight geometry alterations (not keyed interfaces) to guarantee strength in concrete-to-concrete interfaces when differential shrinkage is likely to happen and there are no connectors across the interface. It is suggested that keyed interfaces be considered a matter of further study to remedy the effects of differential shrinkage in such situations, and simplified formulations and recommendations should be provided.

Keywords: Interface shear strength; Precast floors; Differential shrinkage; Composite construction; concrete-to-concrete interface.

Civil Engineering
Annual International Congress

Annual International Congress on Civil Engineering

March 25-26, 2025
Oxford, United Kingdom

Urban Development in Fragile Ecosystems: How Civil Engineering Can Protect Wetlands (2014-2024)

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Abstract

Urban development in fragile ecosystems, such as wetlands, presents a significant challenge for civil engineering within the framework of sustainability. This study examines how civil engineers can implement innovative solutions to safeguard these vulnerable ecosystems while executing urban infrastructure projects. By analyzing the Chilean regulatory framework, including Law 21.202 for wetland protection, we assess its impact on urban planning and civil engineering practices. The research methodology involved a thorough manual review of specialized literature, including articles published in indexed journals focused on civil engineering and law, such as the Journal of Civil Engineering and Management, Water Research, and Environmental Law Review. Publications from 2014 to 2024 that explore the intersection of urban development, civil engineering, and the protection of fragile ecosystems were selected. We also analyzed case studies on green infrastructure and regulations related to wetland conservation in urban settings. The objectives of this research are: (1) to identify international best practices in sustainable engineering applied to wetland protection, (2) to evaluate the effectiveness of Chilean legislation and its implementation in safeguarding fragile ecosystems against urbanization, and (3) to propose guidelines for civil engineers to integrate measures that ensure a balance between urban development and wetland conservation. The results indicate that the adoption of green infrastructure solutions, combined with rigorous compliance with environmental regulations, is essential for protecting wetlands. We will discuss successful examples that demonstrate how engineers can minimize environmental impact and contribute to sustainable development. The results indicate that the adoption of green infrastructure solutions, combined with rigorous compliance with environmental regulations, is essential for protecting wetlands. We will discuss successful examples that demonstrate how engineers can minimize environmental impact and contribute to sustainable development.

Keywords: Fragile ecosysems; Civil engineering; Water Research; Urban development; Environmental law.