54TH ANNUAL GENERAL MEETING AND CONFERENCE

Theme:

"Engineering a Resilient Future: Innovative Solutions for a Sustainable Ghana"

Date:
18th to 23rd March, 2024

Venue:
Fiesta Royale Hotel, Accra, Ghana

GhIE
GHANA INSTITUTION OF ENGINEERING

2024

Special Guest of Honour

Hon. Sam Okudzeto
Member, Council of State

54TH ANNUAL GENERAL MEETING AND CONFERENCE

Ing Kwabena Bempong, FGhIE

President, GhIE

Ing David K. Nyante, FGhIE

Executive Director, GhIE

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History of GhIE

The Ghana Institution of Engineering (GhIE) was officially founded in 1968 to succeed Ghana Group of Professional Engineers, as an autonomous professional body with no political affiliation. The late Ing. Dr. E. Sackey was the first President of the GhIE.

Mission Statement
To develop, promote and sustain sound and competent engineering practice in Ghana comparable to global standards.

Vision
To build and develop a strong world class body by promoting integrity, accountability and professional excellence in the practice of engineering in Ghana.

Core Objectives
- To establish and maintain a register of Engineering Practitioners certified to practice in Ghana.

- To ensure that members of the Ghana Institution of Engineering maintain regulations, guidelines and codes of ethics of engineering practice.

- To ensure that engineering practice in the country conforms to globally established technical, environmental and safety standards.

The GhIE is the professional body responsible for certifying engineering practitioners (Professional Engineers, Professional Engineering Technologists, Engineering Technicians and Engineering Craftsmen) in Ghana and derives its authority from the Professional Bodies Decree NRCD 143, 1973 and the Engineering Council Act, 2011 (Act 819).

The headquarters of the GhIE was initially housed in the premises of Water Resources Research Institute. The vision to own a building befitting the status of the GhIE was realised in 1997, when the GhIE became one of the first professional bodies in Ghana to move into its own building at No.13 Continental Road, Roman Ridge, Accra.

The GhIE Logo is formed by a perfect circle with a spur gear at the centre that is surrounded by a spider's web. The spur gear is considered a recognizable symbol of engineering whilst the spider's web, which is so slim and wonderfully woven to perform a function, expresses ingenuity and strength, which are both attributes required in engineering to solve problems of mankind.

The GhIE logo also symbolises the unity of all the disciplines of engineering viz Civil, Mechanical, Electrical, Chemical,

Agricultural, Marine, Mining, Computer, Biomedical, etc. The GhIE believes that engineering should be the backbone of economic development and progress of our country and that a nation cannot be transformed without a strong indigenous engineering sector. Thus, the institution is up to its responsibilities to Ghana, recognising that most development problems are essentially engineering related.

GhIE plays a major role in ensuring that the standards, regulations and guidelines governing engineering practice are strictly enforced. The institution does not hesitate to investigate cases of unethical behavior and penalise members found to have gone contrary to the GhIE's code of ethics and collaborates with the government to address institutional weaknesses inherent in the engineering sector.

In serving the public therefore, GhIE conducts dispute adjudication and arbitration on request from both the private and public sector and provides advisory services to a variety of entities. GhIE members are often empaneled for interviews aimed at recruitment into engineering related MMDAs and serve on over eighty (80) entity tender committees across Ghana.

GhIE's input to the 'Ghana Beyond Aid' agenda has also been singled out for its brilliance. The 60 page document emphasizes the awareness that without engineering there can be no development and highly recommends use of the power of the National Development Planning process to create wealth and reduce poverty by focusing on the drivers of Industry, Agriculture, Health, Power, Spatial Planning and Infrastructural Development,

Human Resource Development as well as Research and Development. To demonstrate this, GhIE put its money where its mouth is by collaborating with other built environment professionals to develop the first ever Infectious Diseases Centre in Ghana, from conceptualization to the execution.

The Project was completed in 100 days using innovative construction methods. This voluntary contribution was part of a coordinated interdisciplinary effort to support the Ghana Government's response to the COVID-19 global pandemic. The Centre was commissioned on the 24th July 2021 by the Vice-President of Ghana Dr. Mahamudu Bawumia.

In 1999, Women in Engineering (WINE) were grouped into a unit and charged with the responsibility among other things, of spearheading the crusade to encourage young women to consider engineering as an option. To date, WINE has performed this job creditably. Presently, the GhIE has over 10,000 registered members on our database. This includes 159 Fellows, Professional Engineers, Technologists, Trainee Professional Engineers, Trainee Professional Engineering Technologists. Technicians and Craftsmen.

GHANA INSTITUTION OF ENGINEERING

GhIE Anthem

Engineering is the key for development
GHIE stands for Ghana's growth
We conceive, design and build for human basic needs
Protect nature for sustainability

x2

With the help of God
The master engineer backed by excellence and integrity
GhIE is capable of making Ghana great and the
world a better place to live

x2

GhIE is capable!
GhIE is capable!
Let's rise and build our world with hope
GhIE is capable!
GhIE is capable!
Let's rise and build our world with hope.

Lyrics and Anthem Composed By
Professor (Mrs). Esi Awuah (HF-GhIE)

VACC

- Air Conditioning
- Electrical and ELV
- Fire Fighting and Sprinkler
- Plumbing and Piped Services

Digital Infrastructure

Healthcare Services
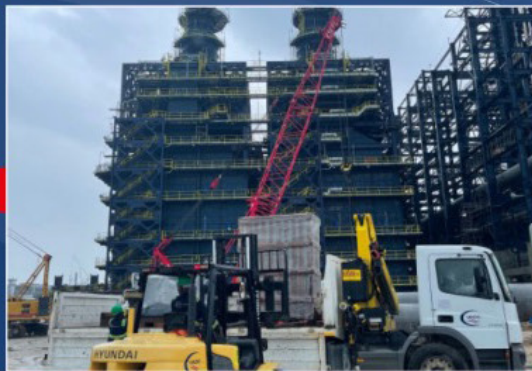
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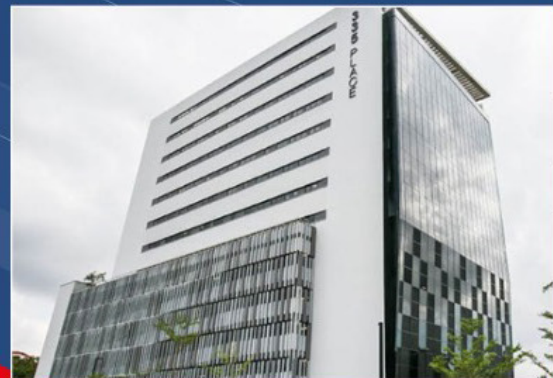
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Welcome Address by GhIE President

On behalf of the Council of the Ghana Institution of Engineering, I warmly welcome you to our **54ᵗʰ Annual General Meeting and Conference**, which has been themed "Engineering a Resilient Future: Innovative Solutions for a Sustainable Ghana".

Last year, our theme was "Resilient Engineering for National Development". Having set the agenda and understood the need for Resilient Engineering as a pre -requisite for National Development, it is imperative to hitherto ensure that we re-affirm its importance for future readiness of our societies by providing innovative solutions that will drive the country and continent to attain the United Nation's Sustainable Development Goals, Agenda 2030.

Ing. Kwabena Bempong, FGhIE

President, GhIE

At last year's Convention of the American Society of Civil Engineers in Chicago, the charge to the World of Engineers was to be FUTURE READY. This year's theme is thus very apt since, as an institution, we recognise the need to include resiliency in our aspirations, and more importantly, to ensure that we provide innovative solutions as engineering practitioners.

Resiliency is the ability to withstand or recover quickly from a difficult condition or shock. Engineering a resilient future involves designing systems, infrastructure, and technologies that can withstand and adapt to various challenges. Developing innovative solutions for the sustainability of our countries requires us, as engineering practitioners, to take a critical look at the following areas:

• Resilient Engineering Infrastructure

• Resilient Cities

• Economic Transformation and Social Inclusion

For a country like Ghana, and dare I say, many third world countries, we are very vulnerable to external shocks such as the current geopolitical wars, pandemics and climate change, with their attendant impact on our economic fortunes. It is thus important that as engineering practitioners, we play our part by designing and providing resilient infrastructure for our development.

This calls for a reconsideration of how we conceptualise infrastructure, collect and analyse design data, design and provide the various infrastructure. We need to design and construct physical systems that can withstand and recover from various

shocks and stresses, including natural disasters, climate change, and human-made disruptions.

This requires the integration of the principles of resilience, such as redundancy, flexibility, adaptability, and sustainability, into the planning, design, construction, and operation of infrastructure projects. These can include transportation networks, buildings, water and energy systems, communication systems, health and more. The overarching aim is to minimize the impact of disruptions, ensure the safety and well-being of communities, and support continued functionality and service delivery, even under adverse conditions.

In order to achieve this, there is the need for interdisciplinary collaboration, innovative approaches, a new mind set and long-term planning to build infrastructure that can withstand the challenges of the future.

Furthermore, it is crucial to reimagine the future of our cities especially with the increasing global rate of urbanisation. For example, the current urban population in Ghana is estimated at 17,472,530 (56.7%), increasing from 12,545,229 (50.9%) in 2010. The urbanisation rate is 3.3 per cent, and almost half (47.8%) of the increase in the population is concentrated in the Greater Accra and Ashanti regions, portraying a non-uniform spread of the phenomenon across the country.

In order to make our cities continuously habitable and sustainable, there is the need for innovative approaches to providing solutions for old problems and understanding new problems of the future. We must therefore consider digital transformation in all our solutions by pushing the boundaries of Internet of things (IoT), Artificial Intelligence (AI), Digital Twins, etc.

The digital transformation of cities involves leveraging technology to enhance urban infrastructure, services, and governance, with the aim of improving efficiency, sustainability, and quality of life for residents. This transformation encompasses various aspects, including:

- Smart Infrastructure: Implementing sensors, IoT devices, and data analytics to monitor and manage critical infrastructure such as transportation systems, energy grids, water networks, and waste management.

- Digital Services: Offering online platforms and mobile applications for citizens to access government services, participate in civic engagement, and receive real-time information about public events, transportation schedules, and emergencies.

- Sustainable Development: Utilizing data-driven insights to support urban planning decisions that promote sustainability, reduce environmental impact, and enhance resilience to climate change.

- Connectivity: Expanding access to high-speed internet and building digital infrastructure to bridge the digital divide to ensure equitable access to information and services, and support economic development and innovation.

- Smart Governance: Implementing digital tools and platforms for transparent, participatory, and data-driven decision-making processes, as well as improving communication and collaboration between government agencies, businesses, and citizens.

Overall, the digital transformation of cities aims to create more connected, efficient, and inclusive urban environments that can better address the evolving needs and challenges of the 21st century. During my Presidential address, I argued for the need to address the housing challenge through the use of locally available and innovative alternative technological solutions. This is important to ensure sustainability of our earth and, invariably, of the human population. There is therefore the need to review our education from our engineering schools and to question some of the approaches to design and construction. We need to begin to think out of the box we have been put into (reimagine engineering solutions) for our future survival.

Finally, it is expected that these innovative solutions will bring about Economic Transformation, which will lead to significant and fundamental changes in the structure, organization, and performance of our economy over time, in line with our development agenda. It will therefore require shifts in key sectors, technologies, markets, and policies that drive growth, productivity, and prosperity. Economic transformation can take various forms, including:

- Industrialization: Moving from agrarian-based economies to industrialized ones, characterized by the growth of manufacturing industries, increased productivity, and urbanization.

- Technological Innovation: Embracing new technologies and innovations that drive productivity gains, create new industries, and disrupt existing ones. This can include advancements in areas such as Artificial Intelligence (AI), biotechnology, renewable energy, and digitalization.

- Globalization: Integrating into the global economy through increased trade, investment, and international cooperation, leading to greater specialization, efficiency, and competitiveness.

- Economic Diversification: Expanding beyond traditional sectors and diversifying the economy to reduce dependence on a single industry or commodity, fostering resilience and sustainability.

- Inclusive Growth: Ensuring that economic transformation benefits all segments of society, including marginalized communities, by reducing inequality, promoting access to education, healthcare, and financial services, and creating opportunities for decent work and entrepreneurship.

We, therefore, would have to embrace the future with hope, a hope not based on wishful or idle thought but one created and engineered today. In doing so, we have to be intentional about providing innovative solutions for the sustainability of our country and by extension our continent and world. We have to be Future Ready.

 I would like to express my sincere appreciation to our international guests who have come from far and near to attend our conference. I welcome our colleagues from Nigeria, Sierra Leone, Kenya, Liberia and Burkina Faso. You are at the centre of the world and in one of the finest hotels in Accra.   Please feel free to enjoy yourselves and take the opportunity to explore the offerings our capital city gives. Akwaaba!

To my beloved GhIE members, I thank you for taking time off your busy schedules to participate in the AGM and Conference. I urge you to attend and learn new things at our technical sessions, make new friends and connect for business opportunities.

I say a big thank you to our major sponsors, Volta River Authority, MC Bauchemie, and VACC Technical Ltd, for your support to the Institution which has made the organisation of this year's AGM and Conference possible thereby lightening the financial burden on members of the institution. Furthermore, our exhibitors during our Building Technology fair as well as those who are exhibiting at this conference, I am grateful for your belief in the GhIE brand and your desire to associate with us.

Finally, our presenters, moderators, rapporteurs, volunteers, Conferences and Programmes Committee, Staff of the GhIE Secretariat and Executive Director, I thank you all for your time and for your continued support to the Engineering Community. God richly bless you.

Opening Ceremony

09:00AM GMT Guest seated /Online Participants

Opening

Safety Protocol Briefing - MC/Fiesta Royale

National Anthem/ GhIE Anthem

Introduction/Context of Conference/AGM
Ing. David K. Nyante FGhIE (Executive Director, GhIE)

Welcome Address by GhIE President -
Ing. Kwabena Bempong FGhIE (President, GhIE)

Acknowledgement of Dignitaries – MC

Fraternal Messages

Interlude

Introduction of Special Guest of Honour
Ing Yaa O. Okudzeto (Chair, Conferences and Programmes Committee, GhIE)

Interlude

Keynote Address – Special Guest of Honour
Hon. Sam Okudzeto (Member, Council of State)

Vote of Thanks
Ing Dr. Lucy Agyepong (Member, Conferences and Programmes Committee, GhIE)

Closing

GHANA INSTITUTION OF ENGINEERING
2024 ANNUAL GENERAL MEETING & CONFERENCE
Theme: "Engineering a Resilient Future: Innovative Solutions for a Sustainable Ghana"

Venue: Fiesta Royale Hotel, Accra, Ghana
Date: Monday, March 18, 2024 - Saturday, March 23, 2024

	Time	Monday March 18	Tuesday March 19	Wednesday March 20	Thursday March 21	Friday March 22	Saturday March 23
	Venue	GhIE Secretariat	Fiesta Royale	Fiesta Royale			
Morning	08:00 – 09:00	Conference Registration	Conference Registration	Conference Registration	Annual General Meeting (GhIE Secretariat)	International Delegates Tour of Arts Centre, Kwame Nkrumah Mausoleum and Makola Market, Accra	Field Trips • Cenpower Generation Co. Ltd. • Cocoa Processing Company • MC–Bauchemie • Fabrimetal	Departures
Morning	09:00 – 11:00	WinE Forum	Opening Ceremony	Panel Discussion: Collaborative and Innovative Solutions to Ghana's Engineering Infrastructure – A Short to Long Term Plan			
Morning	11:00 – 11:30	HEALTH BREAK	HEALTH BREAK	HEALTH BREAK			
Afternoon	11:30 – 13:00	Craftmen's Forum	Time with Exhibitors & Poster Presentations	Industry Project Presentations (Agrivoltaic Technology)			
Afternoon	13:00 – 14:00	LUNCH BREAK	LUNCH BREAK	LUNCH BREAK			
Afternoon	14:00 – 15:00	Youth in Engineering Forum	Keynote Industry Presentation (NCA Director–General)	Plenary Presentation (RAIL Scientific Director)			
Afternoon	15:00 – 16:30	Youth in Engineering Forum	Technical Session 1 (A/B/C) (Q & A)	Technical Session 2 (A/B/C) (Q & A)			
Evening	16:30 – 17:30	EVENING BREAK	EVENING BREAK	EVENING BREAK			
Evening	17:30 – 18:30	EVENING BREAK		WAFEO Meeting			
Evening	18:30 – 21:00	International Delegates Welcome			Closing Banquet & Engineering Excellence Awards (Labadi Beach Hotel)		

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Conference Programme

Tuesday, March 19, 2024		
Moderator: Ing. Harold Esseku, FGhIE		
09:00 - 11:00	**Conference Registration**	
09:00 - 11:00	**Opening Ceremony**	
11:00 - 11:30	HEALTH BREAK	
11:30 - 13:00	**EXHIBITIONS/POSTER SESSION**	
13:00 - 14:00	LUNCH BREAK	
14:00 - 15:00	Keynote Industry Presentation on Conference Theme (Dr. Joe Anokye, NCA Director-General)	
	Technical Session 1A – Integrated Energy Systems **(Chair: Engr. Margaret A. Oguntala Rapporteur: Ing. Dr. Bennetta Koomson)**	
15:00 - 15:10	Predictive modelling of Ghana's energy consumption and corresponding greenhouse gas emissions towards a net-zero future	Yen A. Sokama-Neuyam
15:10 - 15:20	Enhancing energy security and facilitating the transition to carbon neutrality in Ghana	Amo Duodu
15:20 - 15:30	Ghana's electric vehicle policy: a path to aviation industry decarbonization	God'sable S. K. Aidam
15:30 - 15:40	Decarbonisation strategies in the construction sector: assessing emission levels and technological interventions	Jacqueline Sampah-Adjei
15:40 - 15:50	Responsible electricity utilization amidst current energy challenges in Ghana	Bismark Otoo
15:50 - 16:25	Q & A	
16:25 – 16:30	Closing Remarks	
	Technical Session 1B - Resilient Infrastructure Development **(Chair: Ing. Trudy Morgan Rapporteur: Ing. Dr. Jojo F. Ayeh)**	
15:00 - 15:10	Technology innovations as a panacea for resilient infrastructure development in Ghana	Bola Mudasiru

Time	Topic	Presenter
15:10 – 15:20	Cost risk analysis for fiberglass boat construction project in Ghana: a Bayesian network approach	George Obeng/Muhammed Ansah
15:20 – 15:30	Optimization of self-consolidating concrete incorporating waste glass and calcined clay: a comparative study on fresh and mechanical properties	Timothy K. Ametefe
15:30 – 15:40	Waste vehicle tyre generation and their disposal practices in Ghana	Michael Suma Appiah
15:40 – 15:50	Geophysical application for geotechnical site characterization: case study of a bridge site	Joseph K. Oddei
15:50 – 16:25	Q & A	
16:25 – 16:30	Closing Remarks	
	Technical Session 1C – Innovative Solutions for Food and Water Security (Chair: Engr. Joan Nweke Rapporteur: Ing. Dr. Charles Gyamfi)	
15:00 – 15:10	Evaluation of transfer functions and data partition percentages for optimum carbon-in-leach gold recovery prediction using artificial neural network	Adwoa K. Cobbinah
15:10 – 15:20	Estimation of seepage through an earthen dam without drainage structures: a case of Bontanga earthen dam in Northern Region of Ghana	Davis Sibale
15:20 – 15:30	Water stewardship – from theory to action	Delanyo Aheto-Tsegah
15:30 – 15:40	Techno-economic analysis of a GreenDryer for agri-food processing: a case study of maize drying	Paxwell D. Adjei
15:40 – 15:50	Design and fabrication of universal solar dryer with tracking device	Muhammadu M. Muhammadu
15:50 – 16:25	Q & A	
16:25 – 16:30	Closing Remarks	
16:30 – 17:30	**EVENING BREAK**	
	Wednesday, 20th March, 2024	
	Moderator: Ing Dr. Lucy Agyepong	
08:00 – 09:00	**Conference Registration**	
09:00 – 11:00	**Panel Discussion:** Collaborative and Innovative Solutions to Ghana's Engineering Infrastructure – A Short to Long Term Plan	Reps from NCA, GWCL, Urban Roads, and ECG
11:00 – 11:30	HEALTH BREAK / POSTER SESSION	

	Industry Project Presentations	
11:30 - 11:50	Partner Company Presentations	MC-Bauchemie
11:50 – 12:05	Steel sheet pile applications – technical design applications and installation aspects in construction projects	ArcelorMittal Projects Africa
12:05 - 12:20	Energy Technologies for Resilient Development	The Brew-Hammond Energy Centre
12:20 – 12:40	Implementing Agrivoltaic Technology in Ghana: Results from Two Experimental Fields	Agrivoltaic Project Team
12:40 - 13:00	Q & A and Remarks	
13:00 - 14:00	LUNCH BREAK	
	Plenary Session	
14:00 – 14:10	Partner Company Presentations	VRA & VACC
14:10 - 14:40	Artificial Intelligence and Future of Engineering in Ghana	Ing. Prof. Jerry John Kponyo (RAIL Scientific Director, KNUST)
14:40 – 15:00	Q & A and Remarks	
	Technical Session 2A – Resilient Infrastructure Development (Chair: Ing. Prof. Charles Adams Rapporteur: Ing. Nancy A. K. Dzikunu-Bansah)	
15:00 - 15:10	Review of the Ghana Highways Authority pavement design guide	Patrick A. Bekoe
15:10 - 15:20	Improving infrastructure resilience through maintenance error prediction	Mikim Nixon/Enoch Agana
15:20 - 15:30	The role of construction quality assurance in the development of resilient mine waste storage infrastructure	Akua A. Akosah-Yentumi
15:30 - 15:40	Building resilient structures: strategies for preventing structural failures in Ghana	Beatrice Obeng
15:40 - 15:50	Advancing resilient infrastructure: low CO_2 cement as a building block for sustainable infrastructure development in developing countries	Daniel Johnson
15:50 - 16:25	Q & A	
16:25 – 16:30	Closing Remarks	
	Technical Session 2B – Artificial Intelligence and Future of Engineering in Ghana (Chair: Ing. Sophia Tijani Rapporteur: Ing. Dr. Patrick Boakye)	
15:00 - 15:10	Charting the AI horizon: appraisal of awareness and usage of ai technologies among Quantity Surveyors in Ghana	Joshua N. A. Ofori
15:10 - 15:20	Optimizing mining truck tyre life with the introduction of modern sophisticated tools and software	Kwame M. M. Nyampong

15:20 - 15:30	Booking behaviour of customers of ride hailing applications	Emmanuel A. Atiah
15:30 - 15:40	A novel quality assessment method from key driver analysis and Bayesian network modelling	Joseph Fiagbe/Grace Aidoo
15:40 - 15:50	A comparative study of errors in coordinate transformation between Mire X local coordinates system and Ghana National Grid and UTM system.	Edmond Korankye
15:50 - 16:25	Q & A	
16:25 – 16:30	Closing Remarks	
	Technical Session 2C - Innovation and Sustainable Driven Methods **(Chair: Eng. Dadley Toe Rapporteur: Ing. Dr. Bright Akowuah Yeboah)**	
15:00 - 15:10	Systemic risk analysis of ship main engine towards disaster prevention and management	Manyi Tanyi/Mustapha Ceesay
15:10 - 15:20	Best processing route for lead recovery from fire assay slags	Bennetta Koomson
15:20 - 15:30	Ambient air pollution monitoring and health studies using low-cost internet of things monitor within KNUST community	Benjamin Afotey
15:30 - 15:40	Improving ethical engineering practice	Felix N. K. Tetteh
15:40 - 15:50	Effect of nano clay on the rheological and chemical characteristics of asphalt binder	Delali H. Adjei
15:50 - 16:25	Q & A	
16:25 – 16:30	Closing Remarks	
16:30 - 17:30	**EVENING BREAK**	
17:30 - 18:30	WAFEO Meetings	
	Thursday, 21st March, 2024	
09:00 - 14:00	Annual General Meeting	
19:00 - 21:00	Closing Banquet & Engineering Excellence Awards	
	Friday, 22nd March, 2024	
09:00 - 17:00	**Field Trips** • MC-Bauchemie • Cenpower Generation Co. Ltd. • Fabrimetal • Cocoa Processing Company	
	Saturday, 23rd March, 2024	
09:00 - 17:00	**Departures**	

Let's Connect @
Ghana Institution of Engineering 2024 Annual General Meeting & Conference

ArcelorMittal

18 – 22 March 2024 I Accra, Ghana
Engineering a Resilient Future: Innovative Solutions for a Sustainable Ghana

Presentation by ArcelorMittal Projects
20 March 2024

*see event programme for exact time & location

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- Steel sheet pile applications
- Design & installation in civil, mining and oil & gas construction projects

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Poster Presentations

Poster ID	Title of Presentation	Presenter
P1	The bearings of workspace design on employee health	Samuel N. Dorhetso
P2	The role of challenges between maintenance culture and employee safety	Samuel N. Dorhetso
P3	Studies on the use of locally manufactured soaps as alternative collectors for the flotation of iron ores (iron oxides)	John Koomson
P4	GIS analysis of the spatial variability of alluvial gold content in the Kibi-Winneba gold belt of Ghana	Ernest Sarpong Agyei
P5	Utilization of steel slag and high-density polyethylene in asphalt mixtures for improved sustainability	Opeyemi Gbadewole
P6	Asphalt tack coating practices in Ghana	Ahmed K. Mohammed
P7	Development of a smart temperature control device for a biomass-solar assisted dryer	Funchious P. F. Mensah
P8	Identification of prospective aquifer domains within the crystalline basement rocks of Ghana utilizing the ground-penetrating radar	Bernard Ampofo
P9	Towards net zero internet of things system	Davephine Tholley
P10	Green synthesis of chlorophyta seaweed mediated Mn_3O_4 nanoparticles: electrochemical application and disentangling capacitive and diffusive contribution	Lamin Darboe
P11	Critical evaluation of cement quality in pre-construction: ensuring safety and resilient infrastructure development	Solomon Adumatta
P12	Synthesis of calcium silicate hydrate for use as an accelerator in pozzolan cement mortar	Kofi M. Djokoto
P13	Enhancing the super capacitive performance of soot material induced with manganese cobaltite for supercapacitor application	Stephen A. Darko
P14	Capacitive performance of shea butter waste-derived hierarchical activated carbon: from supercapacitor to lithium sulphur battery application	Daniel N. Ampong

Brief Profile of Keynote Speaker

Dr. Joe Anokye

Director General, National Communications Authority

Dr. Joe Anokye is the Director General of the National Communications Authority, a Technology Executive well-versed in a wide range of Telecommunication Operations Management, Regulation, Telecommunication Networks, National Security, and Cyber Security platforms in both public and private sectors. He has been the Director General of the authority since January 2017.

In November 2023, he delivered three (3) lectures at the 12th R.P. Baafour Memorial Lectures at the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi and was awarded an Honorary Doctor of Science Degree (DSc. Honoris causa) at a special congregation on 24th November, 2023, in recognition of his significant contributions to Ghana's Telecommunication Industry.

Dr. Anokye holds a BSc Geodetic Engineering degree from KNUST and Masters in Business Administration from University of Maryland University College, USA. He was awarded a Certificate for Senior Executives in National and International Security by Harvard Kennedy School, Executive Education, USA.

Beginning September 1997, when he was employed at the NASA Goddard Space Flight Center (GSFC), through the end of NASA's Space Shuttle Program in July 2011, Dr. Anokye supported forty-nine (49) Space Shuttle Missions. His team, the NASA (Ground) Communications System (NASCOM), managed the NASA Global Mission Telecommunication Wide Area Network out of Goddard Space Flight Center in Greenbelt, Maryland. In this role, he worked collaboratively in many network installations and troubleshooting exercises worldwide with Telecom and Network engineers from other space agencies in Japan, Germany, Canada, Australia, etc. and the International Space Station (ISS).

Dr. Anokye was a premier Cisco Technical Instructor from the year 1999 through 2016 in the Washington D.C, USA Metropolitan Area. He has served as a member of the National Security Council of Ghana since April 2017 and is, also, a member of the Joint Cybersecurity Committee (JCC) of the National Cybersecurity Authority (CSA).

Ing. Prof. Jerry John Kponyo

Scientific Director, Responsible
Artificial Intelligence Lab
KNUST, Kumasi

Profile of Invited Speaker

Prof. Jerry John Kponyo is the Dean of the Quality Assurance and Planning Office of the Kwame Nkrumah University of Science and Technology (KNUST) under the Vice-Chancellor's Office. Previously, he held the position of Dean of the Faculty of Electrical and Computer Engineering at KNUST. Before assuming the role of Dean, he served as the Head of the Electrical Engineering Department.

He is the Project Lead of the KNUST Engineering Education Project (KEEP), a 5.5 million Dollar Africa Center of Excellence Impact project sponsored by the World Bank with focus on Digital Development and Energy and the Co-Founder of the Responsible AI Network (RAIN) Africa, a collaborative effort between KNUST and TUM Germany.

Between 2016 and 2019 he was a visiting Professor at ESIGELEC, France on a staff mobility programme where he taught postgraduate courses in Business Intelligence and conducted research with staff of ESIGELEC.

He currently leads the Emerging Networks and Technologies Research Laboratory at the Faculty of Electrical and Computer Engineering, KNUST which focuses on digital development technologies research.

Prof. Kponyo is the PI and Scientific Director of the Responsible Artificial Intelligence Lab sponsored by IDRC and GIZ and coordinator of the West Africa Sustainable Engineering Network for Development (WASEND).

He is also the PI for the Partner-Afrika project sponsored by BMZ. He has done extensive research in IoT, intelligent systems and AI and has over 70 published articles in refereed Journals and Conference proceedings and he is a member of the Ghana Institution of Engineering.

ABSTRACTS
OF TECHNICAL PRESENTATIONS AND POSTERS

Predictive modelling of Ghana's energy consumption and corresponding greenhouse gas emissions towards a net-zero future

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Abstract
Ghana aims to reduce its greenhouse gas (GHG) emissions by at least 15 % by 2030 with a more ambitious target to attain net-zero emissions by 2060. However, to achieve its socio-economic development targets, the country will need to more than double its current energy consumption, which will come with high GHG emissions. Apart from the technical and financial constraints, it is important to consider the social cost of carbon (SCC) associated with socio-economic development. This paper seeks to estimate the SCC of Ghana's socio-economic development targets by modelling the energy consumption required to achieve specific targets and the expected GHG emissions using machine learning. It was found that, Ghana will need to increase its energy consumption by over 500 % to attain the developmental status of the current global industrialised countries. Some important underlying factors were also identified, and their impact explored. With the current energy mix of the country, this level of energy consumption will skyrocket GHG emissions, which will come with a high SCC. The country has earmarked natural gas as its transition fuel, which could reduce GHG emissions significantly. The paper proposes attainable solutions to help the country adopt sustainable measures to pursue its socio-economic development targets.

Keywords: Net-Zero, Greenhouse Gas Emissions, Social Cost of Carbon, Energy Consumption, Machine Learning, Predictive Modelling

Enhancing energy security and facilitating the transition to carbon neutrality in Ghana

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Abstract
Ghana holds the potential to attain carbon neutrality through the adoption of sustainable energy, a concept known as leapfrog development. This transition from fossil fuels to renewable energy does not only addresses climate change but also tackles challenges related to energy security and dependency. The rising costs of energy, influenced by global fuel prices, emphasize the urgency for Ghana to shift towards renewable energy sources. The utilization of renewable energy not only combats climate change but also promotes economic growth, improves energy accessibility, and mitigates adverse environmental and health impacts. Qualitative analysis of papers from Scopus and Google Scholar, alongside peer-reviewed scholarly literature and governmental documents, reveals significant insights. The study identifies three crucial strategies to reduce carbon emissions in Ghana's energy sector and address energy security concerns: diversifying energy sources, implementing energy-saving measures, and accelerating the adoption of renewable energy to replace fossil fuels. Moreover, the study emphasizes the ongoing efforts needed to enhance energy efficiency and promote advancements in renewable energy technologies such as solar, wind, hydropower, low-carbon hydrogen, battery electric vehicles, and clean cookstoves. The overhaul of Ghana's energy sector is essential to achieve economic and strategic goals, offering a clearly defined pathway towards both carbon neutrality and enhanced energy security.

Keywords: Carbon Neutrality, Energy Security, Sustainable Energy

Ghana's electric vehicle policy: a path to aviation industry decarbonization

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Abstract
The International Energy Agency reports a surge of over 250 million tons in global carbon dioxide emissions from the transportation sector in 2022, reaching close to 8 gigatons, predominantly fuelled by increased passenger and cargo activities post the COVID-19 pandemic. The aviation sector, constituting 3 % of human-induced CO2 emissions, played a pivotal role in this surge, highlighting the urgent need for transformative measures. The urgency of decarbonizing the aviation sector, especially in Sub-Saharan Africa is underscored, considering its projected contribution to global carbon emissions and the lack of policies to adopt green technologies in the African aviation industry. The paper delves into the transformative impact of Electric Vehicle (EV) in aviation, highlighting the potential of EV adoption in ground operations and emphasizing the need for a robust charging infrastructure. Drawing insights from global case studies, the paper underscores the feasibility and benefits of EV adoption in the aviation industry. Ghana's EV Policy emerges as a pioneering force in the aviation industry's journey towards decarbonization. By strategically harnessing the policy's momentum and lithium resources, Ghana can position itself as a leader in adopting sustainable technologies, contributing to broader international efforts for a greener future in air travel. The National EV Policy should therefore be actively implemented, fostering a phased transition to EVs in the transportation sector to achieve emission reduction goals by 2045. Collaboration between the government and stakeholders should be strengthened to ensure the successful integration of EVs into Ghana's aviation, aligning with global trends for a sustainable and environmentally friendly aviation sector.

Keywords: Electric Vehicles, Aviation Decarbonization, Ghana EV Policy, Sustainable Transportation, Electric Aviation Technologies, Climate Change

Decarbonisation strategies in the construction sector: assessing emission levels and technological interventions

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Abstract
The reduction of carbon emissions in the construction sector is crucial for Ghana to achieve its sustainability objectives. This study investigates the potential for decreasing industrial energy consumption and enhancing resource efficiency in the Ghanaian construction industry in line with the country's goal of an 80 % reduction in carbon dioxide emissions by 2050. Drawing on the UK's Clean Growth Strategy, this research critically assesses the relevance of the strategy in the Ghanaian context, considering the distinctive challenges and opportunities within the construction sector. A comprehensive literature review was carried out to provide a detailed analysis of current emission levels, identifying key areas for mitigation in construction processes and materials through the measurement of carbon emissions and the evaluation of the effectiveness of different technological interventions. The aim of the research was to offer practical insights for stakeholders working towards a resilient, low-carbon future in infrastructure development. Furthermore, this paper not only emphasizes the urgency of decarbonization in the construction industry but also advocates for the integration of resilient practices that strengthen infrastructure against the impacts of climate change. The findings contribute to a comprehensive understanding of how resilient infrastructure development can act as a dual catalyst for mitigating environmental impact and ensuring long-term sustainability in the face of a changing climate.

Keywords: Construction, Carbon Emissions, Decarbonisation, Infrastructure, Resilience, Technology

Responsible electricity utilization amidst current energy challenges in Ghana

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Abstract

Ghana's energy demand is increasing, and the country is facing energy challenges. As of December 2023, the system peak load was 3,618 MW, reflecting a 4.3 % increase from the previous year. In 2024, the system peak load is estimated to reach 3,788 MW, which is a 4.7 % increase. Ghana aims to achieve universal electrification by the end of 2024. To meet the projected peak demand, Ghana has installed capacity of 5,194 MW with a dependable capacity of 4,756 MW, giving a reserve margin of 25 %. However, this available capacity could be reduced to 4,400 MW due to scheduled maintenance and fuel supply leaving a marginal difference of 612 MW between the estimated peak load and available capacity. This paper presented energy efficiency and conservation techniques that will result in bridging the energy balance in compensating for the lack of electricity supply envisioned during the year under review. The paper also brings to light the key roles and responsibilities of stakeholders in power systems planning and optimization in Ghana using supply-side management and demand-side management techniques. Adopting energy-efficient appliances, implementing building codes, and conducting public awareness campaigns are some of the initiatives that can significantly reduce electricity consumption and alleviate pressure on the grid, and are adopted in this paper. Thus, it is essential to promote energy efficiency and conservation measures at both institutional and household levels to be able to meet growing energy demands.

Keywords: Ghana, Energy Demand, Energy Efficiency, Conservation Techniques, Peak Load

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Cost risk analysis for fiberglass boat construction project in Ghana: a Bayesian network approach

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Abstract

Fibreglass, renowned for its resilience and versatility in infrastructural development, is gaining attention in Ghana as a material for boat construction. Wood was the chosen material, but its drawbacks, including its role in deforestation, poor accident resilience, and water ingress issues, have led to the introduction of fibreglass. However, the successful implementation of this innovative boat construction approach is faced with uncertainties, posing risks in project cost estimation, prompting the need for cost risk analysis. Fundamentally, the cost risks stem from the foreign nature of the fibreglass and the scarcity of skilled labour to adapt the material to boat construction projects in Ghana. Port charges, inflation rate, and fluctuating exchange rates all affect the pricing of fibreglass in Ghana due to its importation. A limited pool of skilled professionals trained in fibreglass boat construction (FBC) may cause instability in labour costs, introducing further uncertainty in the cost of FBC in Ghana. Therefore, this research aims to provide insights into the cost-risk landscape of FBC in Ghana, enabling stakeholders to make informed decisions and implement cost-saving strategies. This research uses an advanced analytical framework called Bayesian networks to analyze the factors directly impacting the overall cost of FBC. By creating a dynamic model that depicts the probabilistic correlations between these variables, the Bayesian network enables stakeholders to understand how project costs fluctuate in reaction to associated risk factors. Ultimately, the study contributes to the sustainable development of Ghana's boat construction industry, leveraging fibreglass's resilience as a transformative material for infrastructural advancement.

Keywords: Resilience, Infrastructure, Fibreglass Boat, Bayesian Network, Cost Risk Analysis, Project Cost

Optimization of self-consolidating concrete incorporating waste glass and calcined clay: a comparative study on fresh and mechanical properties

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Abstract
The study developed an optimized self-consolidating concrete (SCC) mix consisting of Portland limestone cement (PLC), calcined clay and waste glass powder using a mixture design of experiment approach. The control mix (CON), containing only PLC was compared to the optimized mix (OPT), evaluating fresh properties (passing ability, filling ability and resistance to segregation), mechanical properties (compressive and flexural strength) and ultrasonic pulse velocity (UPV). In achieving the desired workability, both concrete mixes used polycarboxylate based high range water reducer. Both mixes achieved the specified slump flow diameter and viscosity classifications. However, the OPT mix showed superior deformation capacity. Visual stability analysis confirmed the highly stable nature of both mixes. In terms of mechanical properties, the compressive and flexural strength of the CON mix outperformed the OPT mix at early concrete ages. However, the OPT mix achieved superior mechanical properties at later ages, exceeding the control mix in compression and flexural strength. The UPV analysis indicated excellent concrete quality for both mixes, with UPV values above 4500 m/s at 90 days. The application of the mixture design approach is highly recommended, as all laboratory results consistently aligned with the ranges set during the optimization process, affirming the effectiveness of the approach in achieving targeted fresh and mechanical properties of SCC.

Keywords: Self-Consolidating Concrete, Mixture Design, Waste Glass Powder, Optimization, Mechanical Properties

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Technology innovations as a panacea for resilient infrastructure development in Ghana

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Abstract
Within the last few years, there has been a great upsurge of interest by Ghanaians, engineers, non-engineers and 100 Resilience Cities (100RC), to identify and assess socio-economic factors affecting resilience infrastructure development in Ghana. In an era where built systems are aging or pose significant challenges or can no longer withstand and recover quickly from natural disasters (bushfires, sand domes, floods, storms and cyclones), climate change, and other disruptive events, finding technologically innovative ways to fund and invest in such built systems is crucial. The paper highlights some strategies for investing in resilient infrastructure development that embrace cutting-edge technologies, optimize resources and build sustainable communities. The paper concludes that without implementing and harnessing technology innovations as a panacea for resilience infrastructure development in Ghana, all other socio-economic activities might come to a halt.

Keywords: Technology Innovations, Natural Disaster, Built Systems, Resilience Cities, Resilience Infrastructure

Waste vehicle tyre generation and their disposal practices in Ghana

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Abstract
Improper disposal of waste vehicle tyres (WVTs) poses environmental challenges due to their contribution to air, water, and land pollution. However, WVTs have useful applications in pavement engineering. Modification of asphalt binder or asphalt mixtures with processed WVT is practised elsewhere. However, the benefits of WVT recycling for pavement engineering applications have not been explored in Ghana. One reason could be the lack of empirical data on WVT generation rate and the disposal practices. The objective of this study was to determine the annual WVT generation rate in Ghana to encourage consideration of this waste material in asphalt pavement engineering. A survey was conducted among some educational and health institutions, transport unions, transport companies, waste management companies, vulcanizers, vehicles owners, scrap dealers, and construction companies. A total of 326 respondents were interviewed in Tamale, Kumasi and Accra, which represented the northern, central and southern sectors of Ghana, respectively. The survey, which was conducted between October and December 2023, revealed that, approximately, 470,000 WVTs were produced annually, with 39 % generated by private vehicles, while commercial passenger vehicles and cargo trucks were responsible for 32 % and 29 % of WVT generation, respectively. About 95 % of the WVT generated ended up with scrap dealers, who burned them to extract the steel cords. The findings of this study suggest that significant WVTs are generated annually. Therefore, the use of WVT in pavement engineering applications such as aggregates or bitumen modification or soil stabilization could be considered.

Keywords: Waste Vehicle Tyre, Disposal Practices, End of Life Tyres, Generation Rate

Geophysical application for geotechnical site characterization: case study of a bridge site

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Abstract
A geotechnical site investigation was initiated for the proposed construction of a bridge over the Birim River as part of the Konongo – Ejisu Road Project (KERP). Scope for the investigation, included two borings at each abutment, provided a limited window of subsurface information for adequate geotechnical site characterization. In addition, the level of subsurface heterogeneity, from geotechnical point of view, was significant. The incorporation of geophysical study gave a broader perspective of ground information to support adequate site characterization. This study included Multichannel Analysis of Surface Waves (MASW) for the direct determination of shear wave velocities and consequence evaluation of site-specific peak ground acceleration (PGA); horizontal to vertical spectral ratio (HVSR) for the direct determination of site effect parameters (peak frequencies/periods), depth to sound bedrock, and estimate level of site's vulnerability based on vulnerability index parameter; and seismic refraction to provide broader view and information about ground profiles and presence of any local fault structure. This study discusses the geophysical information obtained at the site to expand and advance the geotechnical characterization of the site and, in addition, promotes the advantages for geophysical inclusion during geotechnical site investigation.

Keywords: Shear Wave Velocity, Multichannel Analysis of Surface Waves, Horizontal/Vertical Spectral Ratio, Geotechnical Site Characterization, Site-effect Parameters, Vulnerability Index

Evaluation of transfer functions and data partition percentages for optimum carbon-in-leach gold recovery prediction using artificial neural network

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Abstract

In the field of mineral processing and extraction, accurate prediction of gold recovery within carbon-in-leach (CIL) processes holds immense significance in operational efficiency and process optimisation. In recent years, artificial neural network (ANN) has proven to outperform the traditional approaches in predicting complex processes like gold recovery. However, the choice of transfer functions and data partition percentage significantly influences the performance of a developed ANN model. This study focused on evaluating transfer functions and data partition percentage to identify the optimal combination that yields the most accurate and reliable predictions using ANN. The study considered all the possible partition percentages, viz. (90–10), (80–20), (70–30), (60–40) and (50–50), along with various transfer functions, viz. TANSIG, LOGSIG, and PURELIN. The back-propagation neural network (BPNN), a choice of ANN model developed using MATLAB, utilised 520 datasets from a CIL circuit of a Ghanaian mine, featuring nine input parameters and one output parameter. Using ranking values for the evaluation of the MSE, MAPE, R and Test performance, the result showed that the combination of LOGSIG-PURELIN with a data partition of (90-10) outperformed all others and, hence, regarded as the overall best model. However, the combination LOGSIG-TANSIG performed best in the percentages of 80-20, 70-30, 60-40 and 50-50. This study contributes to advancing accurate and efficient gold recovery predictions, ultimately enhancing the operational performance and sustainability of the CIL extraction process.

Keywords: Carbon-In-Leach, Gold Recovery Prediction, Data Partition, Transfer Function, Back-Propagation Neural Network, Artificial Neural Network

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Estimation of seepage through an earthen dam without drainage structures: the case of Bontanga earthen dam in Northern Region of Ghana

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Abstract

Absence of downstream drainage structures and in-built monitoring features at Bontanga earthen dam creates a challenge for direct measurement of dam seepage. The study was undertaken to explore various approaches for estimation of seepage through the earthen dam. Four methods were employed in the study, namely: field method based on Darcy's principle, SEEP/W Model (numerical approach), Schaffernak-Van Iterson (analytical approach), and Empirical Model. Dam seepage discharge results from all approaches did not differ significantly at 5 % level of significance (p = 0.857). When compared to the field method, SEEP/W model, Schaffernak-Van iterson, and empirical model performed well with coefficient of determination (R^2) of 0.9689, 0.9361, and 0.9580; Root Mean Square Error (RMSE) of 1.92×10^{-7} m³s⁻¹, 4.5×10^{-7} m³s⁻¹, and 2.51×10^{-7} m³s⁻¹; Mean Absolute Percentage Error (MAPE) of 5.8 %, 10.2 %, and 7.1 %, respectively. The study also showed that the developed empirical model can successfully estimate seepage discharge through Bontanga earthen dam. Considering all the approaches, the maximum dam seepage discharge was 7.70×10^{-6} m³s⁻¹ and it falls within the acceptable limit ($< 1.31 \times 10^{-5}$ m³s⁻¹). However, a drainage system should be incorporated at the base of the downstream face to safely drain seepage water and ensure sustainable operation and management of the earthen dam.

Keywords: Analytical Approach, Darcy's Principle, Earthen Dam, Empirical Model, Numerical Approach, Seepage

Water stewardship – from theory to action

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Abstract
Water is abundant on the Earth but only a small portion, an estimated 0.03 %, is available for use by man. Furthermore, climate change and the resulting variability in weather patterns increases the water related risks such as floods, droughts and in some extreme cases, desertification. These risks have caused governments and industries to strategize how they use water and implement actions to ensure that water related risks are managed efficiently. In 2015, the United Nations Industrial Development Organization (UNIDO) initiated the water stewardship strategy as part of managing water related risks. Water stewardship has been defined by UNIDO as "using water in a way that is socially equitable, environmentally sustainable and economically beneficial". Water stewardship helps water users to integrate managing their risks with capitalizing on the water-related opportunities within their catchment to promote long-term water security. Heavy water users such as the mines and breweries are embarking on this journey and continue to improve their water use efficiency targets within their catchments. This paper looks at developing and implementing a water stewardship strategy using a case study in a mine in Ghana.

Keywords: Water Stewardship, Water Balance, Water Use Efficiency, Water Security

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Techno-economic analysis of a GreenDryer for agri-food processing: a case study of maize drying

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Abstract
In African agrifood systems, post-harvest losses are exacerbated by dependence on inefficient traditional drying methods which impact crop quality and food security. To address this challenge, an innovative solution, the GreenDryer, which harnesses biomass and solar energy to provide a sustainable and efficient drying alternative has been developed. The GreenDryer operates through a three-compartment system: the combustion chamber, blower unit, and drying chamber. Agro-wastes are efficiently burnt in the combustion chamber to generate the needed heat, which is sucked and directed into the drying chamber, ensuring consistent and effective drying regardless of weather conditions. Technical performance assessment of the dryer showed an average air temperature of 73.54 °C in the plenum, which reduced the moisture content of wet maize from 23.25 % (w.b) to 13.61 % (w.b) at an average drying time of 2.5 hours. This resulted in a drying rate, drying efficiency, and specific energy consumption of 9.50 kg/h, 71.37 %, and 25.70 MJ/kg, respectively. At a drying charge of US$ 2.4 per 100 kg bag of maize, the investment cost could be regained at a pay-back period of 6 months and 15 operation days and a benefit-cost ratio of 1.27. The drying system is economically viable at a net present value of US$1,313.48 and an internal rate of return of 44 %. Adopting the dryer could contribute to reducing post-harvest loss of maize at the smallholder level and increase farmer's income.

Keywords: GreenDryer, Agro-Waste, Maize Drying, Technical Performance, Economic Analysis

Design and fabrication of universal solar dryer with tracking device

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Abstract

A solar dryer with tracking has been developed to make a maximum use of the solar energy for drying products, especially agricultural products such as tomatoes, vegetables, etc. The framework of all the parts of dryer concept was designed, fabricated and tested using available materials that was sourced locally. Preliminary tests with no load to the dryer showed that the solar collector raised the ambient air temperature from 20 °C to 41 °C to warm air of 28 °C to 64 °C between the morning and midday. This lowered the relative humidity of the air from an average of 26 % in the morning to 5 % at midday. The dryer, loaded at 5 kg/m, dried tomato slices of 8 mm thickness from initial moisture content of 93.3 % to final moisture content of 12 % in 13 hours and11 hours when operated under natural convection current. Using forced ventilation, the slices of tomato took 11 hours to reach final moisture contents of 12 %. The open air-sun drying tests conducted side by side with solar drying needed an average of 20 hours to reach the same final moisture contents for tomato slices. The maximum drying rate of tomato slices attained under natural convection and forced circulation were 3.1 and 2.8 kg of water per kg of dry matter-hr. For the open-air sun drying, the maximum drying rates for tomato slices were 1.5 kg of water per kg of dry matter-hr. The dryer was able to remove 52.8 % of moisture while tracking the sun, dry basis, from 4.6 kg of product in one day of 10.00 hours drying time, which is about 0.46 kg/hr drying rate. The efficiency of the dryer was to be 65.7 %. From economic feasibility and payback analysis of the solar dryer, the payback period was determined and was very small compared to the life of the dryer; hence, the dryer dry product free of cost for almost its life period of 15 years.

Keywords: Tracking Device, Solar, Dryer, Universal, Efficiency, Convection

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Review of the Ghana Highways Authority pavement design guide

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Abstract

The pavement design guide of the Ghana Highways Authority (GHA) has been in use for over two decades without review. This has caused many pavement engineering practitioners to rely on other pavement design guides especially that of the United Kingdom, European Union, South Africa and the United States when designing roads in Ghana. This trend has caused a lot of inconsistencies in pavement structures constructed in Ghana and in some cases resulted in pavements that are not locally resilient. The advancement in pavement material technology characterization coupled with a better understanding of locally available materials, and new analysis and design tools approaches have made the need for the review eminent. There is however no literature currently available detailing the road map the GHA has in updating the guide. This paper therefore undertakes a critical review of the pavement design guide, highlighting areas requiring critical review through the use of a comparative analysis approach. Changes to the key components are proposed using literature from countries with similar climatic conditions and international best practices or the author's experience. The paper further gives strategic ways through which GHA can develop a sustainable pavement design manual that can be updated every five (5) years using locally gathered data. Finally, the paper proposes cost-effective incremental changes to be made commencing from the year 2024.

Keywords: Ghana Highways Authority, Pavement Design Guide, Review

Improving infrastructure resilience through maintenance error prediction

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Abstract

Maintenance improves infrastructure resilience and longevity. Meanwhile, not all maintenance works are successful; errors happen, resulting in maintenance failures. These errors are termed maintenance errors, and several causes have been attributed to their occurrence. When maintenance error occurs, the infrastructure undergoing repairs delays returning online, impacting its availability and resilience. Therefore, it is possible to study infrastructure resilience by predicting the maintenance error rate (MER) for organisations or the maintenance department. Through probabilistic risk analysis (PRA), the present study aims to develop a data-driven tool for predicting an MER based on the prevalence of known maintenance error causes (MECs). In PRA, the MECs are linked together using the Naïve Bayes' theorem to estimate a percentage score as the MER. With the estimated MER, an organisation can now assess the quality of its maintenance operations and the impact on the resilience of physical structures and facilities undergoing maintenance. The development and application of the tool are demonstrated through a maritime case study. The present study is recommended to maintenance departments in Ghanaian industries for analysing their maintenance operations quality, alongside the state of availability and resilience of their infrastructural assets undergoing maintenance.

Keywords: Infrastructure Resilience, Maintenance Error, Probabilistic Risk Analysis, Data-driven Tool, Naïve Bayes', Conditional Probability

The role of construction quality assurance in the development of resilient mine waste storage infrastructure

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Abstract

The mining industry has since the early 1900s managed the disposal of waste generated from the processing of ore by the construction of Tailings Storage Facilities (TSF). Just as the method of designing and construction of the facilities have evolved over the years, so have the standards and guidelines surrounding the construction and operation of these facilities. This has resulted in many mines acknowledging and taking responsibility for the sustainability of their facilities. Defects in construction are one of the most common causes of litigation in the construction industry. The presence of defects in a completed facility may compromise its effectiveness and render it unsuitable for the intended purpose. Similarly, the consequences of defects in TSFs could range from costly remediations to hefty fines and potential jail time in the case of fatalities. In the year 2020, the International Council on Mining and Metals (ICMM) published a global standard (Global Industry Standard on Tailings Management) with the objective of zero harm to people and the environment during the construction, operation and closure of TSFs. The guideline leaves no ambiguity in the need for competent and licensed designers as well as a transparent quality assurance program during construction. This paper presents case studies to demonstrate how a good quality assurance program in the construction of TSFs contributes to improving the resilience of these facilities.

Keywords: Tailings Storage Facility, Construction Quality Assurance, Global Industry Standard, Tailings Management

Building resilient structures: strategies for preventing structural failures in Ghana

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Abstract
This research focuses on addressing structural failures and building collapses in developing countries, particularly in Ghana, by proposing strategies to enhance the resilience of structures. The study identifies the surge in building collapses in developing countries, with a specific emphasis on Ghana. The research attributes the causes predominantly to man-made factors, particularly poor supervision, leading to issues such as substandard workmanship, non-compliance with building codes, and the use of inferior materials. Also, lack of soil investigations before design and construction as well as clients not involving professionals in building projects. While the literature and surveys underscore human factors as primary contributors, the statistical index of building collapses indicates that natural disasters, including rainstorms, windstorms, and floods, have also significantly impacted Ghana. The proposed mitigation strategies for building collapses in Ghana encompass rigorous supervision throughout the construction process, from the design stage to completion. Key components include the use of high-quality building materials, continuous training of the workforce to ensure skilled labor, strict adherence to building codes and regulations, periodic reviews of building regulations to streamline compliance, and comprehensive inspection routines during and after construction to ensure quality assurance. Moreover, involving professionals in building projects is highlighted as a crucial measure. The research also explores barriers to the implementation of mitigation strategies in Ghana. These barriers include weak enforcement of building codes, regulatory bureaucracy, high implementation costs, insufficient financial resources, corruption, and resistance to change within the industry. Recognizing and addressing these barriers are imperative for the successful implementation of strategies aimed at preventing building collapses in Ghana.

Keywords: Buildings Collapse, Resilient Structures, Building Materials, Collapse Mitigation, Quality Assurance

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Advancing resilient infrastructure: low CO_2 cement as a building block for sustainable infrastructure development in developing countries

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Abstract

The demand for infrastructure and housing in developing countries is increasing rapidly, presenting a challenge to balance meeting these demands and mitigating negative impacts on the environment. Cement, a widely used construction material, is associated with high energy consumption and greenhouse gas emissions. In fact, the production of 1000 kg cement is responsible for an estimated 900 kg of CO_2 emissions and 5 billion joules of electric power and fuel energy. About 5-10 % of the global carbon dioxide emissions are known to be emanating from the production of Portland cements. This paper explores the potential of low CO_2 cement solutions, such as Magnesium Cement and Limestone Calcined Clay Cement (LC3), as building blocks for sustainable infrastructure development in developing countries. By evaluating the environmental impact, performance, and feasibility of these alternatives, this study aims to provide insights into how these materials can be effectively utilized to meet the increasing demand for construction materials in a sustainable manner. In addition to highlighting the benefits of low CO_2 cement alternatives, this paper also emphasizes the importance of using local materials, optimizing performance, and ensuring cost efficiency to promote the widespread adoption of these sustainable construction materials. By advancing resilient infrastructure using low CO_2 cement, developing countries can meet their housing and infrastructure needs while contributing to global efforts to reduce emissions and combat climate change.

Keywords: Low CO_2 Cement, Sustainable Infrastructure, Magnesium Cements, Environmental Impact

Charting the AI horizon: Appraisal of awareness and usage of AI technologies among quantity surveyors in Ghana

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Abstract

In the current landscape, various industries, most notably in the engineering sector, are embracing the integration of Artificial Intelligence (AI) technologies into their operations. Despite the proliferation of studies investigating the awareness and use of AI technologies across various engineering disciplines, there is a notable lack of information regarding the awareness and use of AI technologies within the domain of quantity surveying, although quantity surveyors are critical in orchestrating the paradigm shift towards an AI-driven engineering sector. To address this gap, the current study provides a meticulously crafted and evidence-based assessment of AI awareness and usage among quantity surveyors working on projects in Ghana. To do this, a comprehensive questionnaire survey was designed to elicit information from quantity surveyors affiliated with the Ghana Institute of Surveyors. Using descriptive statistics and fuzzy synthetic evaluation methods, the collected data was rigorously examined to determine the levels of awareness and the adoption of AI tools by quantity surveyors in their work process. The findings suggest that AI technologies are underutilized in terms of quantity surveying practices. In light of these findings, the study proposed and developed a roadmap to incentivize and facilitate the usage of AI technologies by quantity surveyors on construction projects in Ghana.

Keywords: Artificial Intelligence, Quantity Surveyors, Engineering Projects, Fuzzy Synthetic Evaluation

Optimizing mining truck tyre life with the introduction of modern sophisticated tools and software

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Abstract

Truck tyre health is paramount in achieving improved equipment availability, operational reliability, and utilization efficiency while keeping costs to a minimum. The major causes of equipment failures in truck tyres, such as the Caterpillar 785C, Loader 992K, Grader 16M and others, are high temperatures and pressures. To monitor and mitigate these issues, various methods of condition monitoring have been utilized, focusing on tracking high temperatures, high pressure levels, and tire wear. Among the available condition monitoring systems, Karl Tyre has introduced the iTrack system, which represents the latest and most advanced technology in this field. The system provides accurate real-time measurement and monitoring of tyre pressure and temperature. However, the iTrack system requires an internet connection or network to fully utilize its capabilities. One significant advantage of the iTrack system is that it reduces the need for direct contact between technicians and tyres during pressure and temperature checks. This feature minimizes the risk of fatalities associated with tyre handling. In summary, maximizing tyre life necessitates precise measurement and monitoring of tyre pressure, temperature, and wear rate. The objectives of this research include reducing the high risk of fatalities, minimizing human involvement in monitoring tyre pressure, temperature, and wear rate, and ultimately improving tyre life on mining equipment.

Keywords: Haul Truck, Tyre Monitoring System, Off the Road Tyres, Safet

Booking behaviour of customers of ride haiing applications

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Abstract
Ride hailing utilizes online platforms to connect riders with a pool of drivers. While many bookings are made daily, a significant portion gets cancelled, affecting platform availability and wasting drivers' productive hours. This study examined booking behaviour among ride hailing app users in the Kumasi Metropolis. Using mixed method survey techniques, 426 commuters were randomly selected and interviewed. The findings were analyzed through descriptive statistics and thematic analysis. The majority of ride hailing app users within the study area were young, unmarried, Christian male adults (21 – 31 years), and relatively new residents in their respective locations. These users utilized ride sourcing about 2-3 times per week, covering 1 – 2 km distance, primarily, on weekends. Interestingly, nearly 90 % of participants had previously cancelled a trip. Reasons for cancellation ranged from long waiting times, discrepancies in driver or vehicle details, additional charges demanded by the driver, or accidental requests. Around half of the study participants expressed satisfaction with ride hailing services in the Kumasi metropolis. Those unsatisfied raised concerns about poor trip behaviour. To improve ride sourcing services in the area, proactive efforts are needed from transport operators, agencies, and all stakeholders. Regular training and workshops should be organized for ride hailing app drivers to meet customers' expectations and, potentially, reduce trip cancellation rates.

Keywords: Ride Hailing, Booking, Cancellation, User Behaviour

A novel quality assessment method from key driver analysis and Bayesian network modelling

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Abstract
Quality assessment (QA) ensures that products developed, and services rendered match customers' descriptions and satisfaction. In engineering education, the programme evaluation form (PEF) is the main tool institutions use to collect information from students to assess the quality of courses delivered. The PEF contains much information that can be leveraged for detailed QA analysis through data mining. As a result, the present study employs the key driver analysis (KDA) and Bayesian network (BN) modelling techniques to data mine the PEF, leading to new insights about the quality of course delivery to students. The literature review shows little about using KDA and BN for QA. Thus, the evolving QA method in the present study is an innovation. It provides more insights into students' satisfaction with courses delivered by lecturers. Some of these insights, such as the success and disaster sequences that show how a student's perception about the quality of programme course delivery changes for good or bad over time, are absent in the traditional way PEF is used to do QA. While in the methodology, the KDA collects information on the key performance indicators (KPI) for quality course delivery, the BN was used to reduce KPIs of more than two to precisely two. That way, producing a performance-importance matrix for adjudging the quality of programme course delivery in educational institutions is possible. This QA method is recommended to the leadership of engineering institutions in Ghana as an innovative and sustainable approach for QA of engineering programmes.

Keywords: Quality Assessment, Key Driver Analysis, Bayesian Network, Engineering Education, Performance-importance Matrix, Key Performance Indicators

Green synthesis of chlorophyta seaweed mediated Mn_3O_4 nanoparticles: electrochemical application and disentangling capacitive and diffusive contribution

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Abstract

This study focuses on the sustainable synthesis of Mn_3O_4 nanoparticles using Chlorophyta (green) seaweed extracts through a green chemistry technique for electrochemical capacitor applications. XRD, UV-visible, SEM, EDS, and FTIR were used to evaluate the green produced Mn_3O_4 nanoparticles in order to determine their crystallinity, structure, shape, and elemental composition. The electrochemical behaviour of the green synthesized Mn_3O_4 was examined through CV and EIS. The XRD results showed diffraction peaks that correspond to Hausmannite Mn_3O_4 phase, with a 24.4 nm-sized crystallite on average. When compared to bare Ni electrode, the electrochemical analyses showed a voltametric response that was 17 times higher. For kinetics of the electrochemical reaction, the computed values of the charge transfer coefficient (α_a) and apparent electron transfer rate constant (k_s) were 4.0 s^{-1} and 0.33, respectively. The diffusion coefficient, as determined through the Randles-Sevcik equation, was observed to be 1.78×10^{-6} cm²/s. The analysis conducted at various scan rates revealed a diffusive contribution of 90.6 % at 5 mV/s and 67.7 % at 100 mV/s. In contrast, at a scanning rate of 100 mV/s, the capacitive contribution increased from 9.4 % to 32.3 %. The time allowed for the interaction between ions and electrode material at various scan rates is responsible for the observed reduction in the diffusive component and the increase in the capacitive

Keywords: Manganese Oxide, Green Synthesis, Electrochemical Capacitor, Diffusion Coefficient

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Systemic risk analysis of ship main engine towards disaster prevention and management

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Abstract

Disasters continue to occur in the industry due to systems failure. The identification of industrial systems whose failure may lead to a disaster is a significant step in the process of disaster management preparedness. Thus, these systems pose a systemic risk to the industry since when a disaster occurs, operations must immediately be halted and in extreme cases, the industrial plants shut down. Becoming aware of the systemic risk posed by such systems periodically will be a major way of measuring the disaster potential of a system. Appropriate steps can then be taken to minimise the chances of a disaster occurring if the measurement indicates a higher occurrence score. The present study aims to demonstrate how systemic risk analysis (SRA) can be leveraged to prepare for and manage disasters. With transportation playing a central role in global trade and maritime transport handling over 80 % of the world's trade commodities, the present study chooses the two-stroke main engine for ship propulsion to demonstrate SRA. A ship transporting cargo over the ocean only carries one main engine, and its failure will plunge a ship into disasters such as collision or grounding accidents, ship loss, and marine pollution. Through the Bayesian network, an SRA model is developed and used to assess and manage the possibility of disaster occurrence. This study could guide Ghanaian industries in developing and applying the SRA method for disaster management and preparedness by focusing on systems whose failure would cause disasters.

Keywords: Systemic Risk Analysis, Disaster Management and Preparedness, Main Engine, Ship Propulsion, System Failure, Bayesian Network

Best processing route for lead recovery from fire assay slags

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Abstract

In Ghana, voluminous amounts of slags are generated by fire assay laboratories. Since lead is a major constituent in fire assay slags, there is a possibility of lead finding its way into the slag matrix and being released into the geo environment upon disposal. This work ascertains the possible amount of lead in the slags and recovers it using flotation, gravity concentration and acid-leaching methods. The initial samples were chemically characterized using an X-ray fluorescence (XRF) and acid-digested for Atomic Absorption Spectroscopy (AAS) analysis. The results indicate that fire assay laboratories have elevated heavy metal concentrations especially lead (Pb), which is above the Ghana Environmental Protection Agency (GEPA) and World Health Organization (WHO) permissible levels, demonstrating anthropogenic impacts. From the study, the recoveries were found to be 77.83 %, 77.09 % and 76.42 % for flotation, gravity separation and acid leaching respectively. It is concluded that the gravity separation method is the best processing route for lead recovery from fire assay slags since the gravity separation poses little or no environmental dangers whereas flotation and acid leaching processes require chemicals that can cause skin irritation and other adverse effects. Also, the gravity separation process requires less time to perform.

Keywords: Fire Assay Slag, Flotation, Gravity Concentration, Acid-leaching

Ambient air pollution monitoring and health studies using low-cost internet of things monitor within KNUST community

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Abstract

Urban environments with high industrialization are infested with hazardous chemicals and airborne pollutants. These pollutants CO, O_3, SO_2, NO_2, and PM can have devastating effects on human health, causing both acute and chronic diseases such as respiratory infections, lung cancer, and heart disease. Air pollution monitoring is vital to warn citizens of the health risks associated with exposure to high concentrations of these criteria pollutants. This study designed a low-cost Internet- of-Things (IoT) monitor to measure concentration levels of criteria pollutants emitted from transportation sources within Kwame Nkrumah University of Science and Technology (KNUST) environs. Three monitoring sites, KNUST Tech junction, Ayeduase gate junction and KNUST campus junction, were identified as the locations within the proximity of the University for the deployment of the monitor. Hourly and mean daily CO, NO_2, O_3 and SO_2 concentrations at each of the three sites were measured for a week using the IoT monitor when students were in school and on vacation. The average daily CO, NO_2 and O_3 concentrations measured at the selected locations when school was in session and during vacation were presented on histogram. The mean weekly concentrations of CO, NO_2 and O_3 were also estimated as 13.2 ppm, 0.277 ppm and 0.110 ppb respectively at KNUST Tech junction; 10.1 ppm, 0.254 ppm and 0.100 ppb respectively at Ayeduase gate junction; and 8.0 ppm, 0.415 ppm and 0.106 ppb respectively at the KNUST campus junction when school was in session. The results show that the concentrations of all the pollutants were higher and exceeded the EPA standards except for CO at KNUST Campus junction monitoring site. These high levels of emissions are a health concern for the students at the university and the authorities need to device means to curb it.

Keywords: IoT Monitor, Criteria Pollutants, Health Impact, Emission Standards, KNUST Campus

Improving ethical engineering practice

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Abstract
Over the years concerns over unethical conduct within the Ghanaian society in general and the engineering profession, in particular, have led to the resurgence of the debate on the need, and how to promote or improve on the core ethical values in the Engineering professional practice. Although, there are professional systems and structures in place aimed at preventing or mitigating the effects of unethical behaviours such as bribery, corruption, substandard work, misuse of national resources and confidential information in public service organizations, these societal ills persist. There is therefore an urgent need to examine the underlying factors and root causes of such development-limiting tendencies and help professional engineers to uphold standards and ethical values in their execution of duties. The production of knowledge in engineering is located both in science as well as in social life. Further, Engineers do not use only scientific knowledge in their practice but also combine labor and capital in their application of this knowledge. Being employed in the public and private sector and working toward commercial ends, engineers are both the "objects and representatives of corporate power". As such, engineers are faced with ambiguities and issues concerning the use and abuse of power, which other professions are not. Therefore, the call to promote or improve on the core ethical values in engineering practice is the need of the hour.

Keywords: Ghanaian Society, Values, Morality, Ethics, Abuse of Power, Social Life

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Effect of nano clay on the rheological and chemical characteristics of asphalt binder

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Abstract
Increased axle loads, climate change and harsh environmental factors facilitate early aging, deterioration, and premature failure of pavements. Nanomodification of asphalt binders has been used to improve the durability of pavement construction. This study investigated the effect of nano clay on the rheological and chemical characteristics of AC-20 asphalt binder. A shear mixer was used to blend the nano clay and AC-20 in dosages ranging from 1.0 % to 3 %, in 0.5 % increments by weight. The Dynamic Shear Rheometer (DSR) and the Fourier transform infrared spectroscopy (FTIR) were used to determine the complex shear modulus G^* and microstructure distribution of modified asphalt binders, respectively. The short and long-term aging of the binder was simulated using the rolling thin film oven (RTFO) and pressure aging vessel (PAV) tests. The FTIR showed no formation of new peaks. However, the addition of nano clay to the asphalt binder resulted in slight increases in the characteristic peak intensities at, 2919-2851 cm^{-1}, 1030 cm^{-1}, and 650 cm^{-1} regions due to the stretching and bending vibrations of the C=C, C-O bonds in the nano clay, hence no chemical interactions occurred. Resistance to rutting ($G^*/\sin\delta$) and fatigue cracking of nano clay-modified binders increased. However, beyond 2%, the resistance to fatigue cracking declined. Rheologically, nano clay modification could improve asphalt binder rutting and fatigue resistance, up to 2 % nano clay addition.

Keywords: Nanomodification, Nano clay, Performance Grading, Dynamic Shear Rheometer

The bearings of workspace design on employee health

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Abstract
At present computer workstations have become crucially essential to most occupations and employees spend ample time using them. Hence, health issues emerging from their design and use must be properly examined and the gaps due to the dearth of sufficient knowledge on how they affect employee health through the incidence of musculoskeletal disorders (MSDs) must be filled. Henceforward, the purpose of the current study is to examine the effects of workspace design as well as the control effects of work posture on the health of employees, captured as the tendency of MSDs. A positivist research approach would be adopted for this study and data would be collected from respondents in the finance, insurance and education industries within the Greater Accra Region using a 5-point Likert scale close-ended questionnaire. The data garnered would be evaluated with bivariate correlation and regression analysis, facilitated by the statistical package for the social sciences software and discussed. Also, the findings would be presented and comprehensively discussed. The findings of the study would be used primarily within the context of the industries studied. However, the verdicts may be generalized to add on to literature, since theoretical and empirical findings are equally relevant universally. It is envisioned that the yields of this study would inform strategic decisions regarding workspace designs by firms to create and maintain remarkable levels of health amongst employees and help reduce the frequency of work-related MSDs.

Keywords: Workspace Design, Musculoskeletal Disorders, Workstation Layout, Work Posture, Employee Health

The role of challenges between maintenance culture and employee safety

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Abstract
The maintenance of assets of an organization within an environment that facilitates employee safety is essential to its growth. However, there is a dearth of detailed knowledge on how maintenance culture and its challenges influence employee safety. Thus, this treatise's foci are to examine the direct influences of both maintenance culture and its challenges on employee safety as well as the mediating role of the challenges on the link between maintenance culture and employee safety. A positivist explorative research approach would be adopted for this study and data would be collected from staff within a specific firm's maintenance unit. A 5-point Likert scale closed-ended questionnaire would be used for the survey. The data garnered would be evaluated with partial least squares structural equation modelling (PLS-SEM) of regression analysis. The findings of the study regarding the direct effects of both maintenance culture and its challenges on employee safety and the type of mediation of the challenges between the path of maintenance culture and employee safety would be presented and discussed. It is envisaged that the findings of the study could be used primarily within the context of the transport maintenance industry. However, the verdicts of the study may also be generalized for usage in other fields, as it would add on to literature. It is projected that the yields of this study would inform strategic resolutions on maintenance culture by firms to create and maintain impressive levels of employee safety.

Keywords: Maintenance Culture, Employee Safety, Budgetary Allocation, Spare Parts, Preventive Maintenance

Studies on the use of locally manufactured soaps as alternative collectors for the flotation of iron ores

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Abstract

Industrially approved collectors are known to be expensive in the mining sector, which raises production costs. This research shows how three locally manufactured soaps can be used as an alternative for collectors in the flotation process. The chemical composition of the iron oxide sample was determined using X-ray fluorescence (XRF). The soaps were graded according to total fatty matter, free caustic alkali, and lather volume to demonstrate their quality. The iron oxides, which made up 67 % of the total weight, were floated with naphthalene as a frother and locally manufactured soaps, namely Key Soap, Alata Soap, and Azumah Blow Soap, at a collector dosage of 0.6 ml, 1 ml, and 1.4 ml. This was done to establish which soap is the most efficient collector and the dosage that results in the best recovery. An Atomic Adsorption Spectrometer (AAS) was used to analyze the iron content reported in the digested iron oxide feed, concentrates and tailings. The study demonstrates that all the soaps performed well as collectors. Alata soap generated the highest yield of 71 % at 0.6 ml. The studies also reveal that the total fatty matter, free caustic alkali, and lather volume of locally made soaps have a positive influence on the flotation of iron oxide. However, only Key Soap met all the specifications for soaps by the Ghana Standards Authority.

Keywords: Collector, Soap, Recovery, Total Fatty Matter, Free Caustic Alkali, Lather Volume Standards

GIS analysis of the spatial variability of alluvial gold content in the Kibi-Winneba gold belt of Ghana: implication for the distribution of mineralization

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Abstract

On rare occasions, linear and nonlinear geostatistics is applied in Geographic Information System (GIS) technology, however it is frequently utilized in ore grade estimation. In this study, GIS technique was used to investigate the spatial distribution of alluvial gold content, mineralized and overburden layer thicknesses from 171 pits at the Kibi area with the aim of determining the controlling factors affecting the spatial distribution of gold mineralization. The deposit contains fine and nuggets of gold in gravel profiles which are covered by sharply contrasted overburden materials. The gravel portions were sampled and assayed by washing to determine the gold grade of each pit. Gold content varies between 0 and 4.51 g/m^3. Both mineralized and overburden layer thicknesses show randomly spatial distribution and there is no correlation between these parameters and the gold content. This approach has demonstrated that the Kibi area is in a large shear zone compatible with fault systems and composed of different fractures oriented in NE-SW and NNE-SSW respectively. These faults system and fractures could have controlled this gold mineralization. These structures can lead to the delineation of the most prospective areas for the exploration of primary gold deposit in the study area using GIS analysis.

Keywords: Geographical Information System, Kibi Gold Belt, Alluvial Gold Deposit, Mineral Exploration

Utilization of steel slag and high-density polyethylene in asphalt mixtures for improved sustainability

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Abstract
Steel Slag (SS) and High-Density Polyethylene (HDPE), individually, have proven to be effective substitute and modifier for aggregates and bitumen, respectively. SS is a waste product obtained from steel production, and has high strength and abrasive resistance, which makes it a good substitute for aggregates in asphalt concrete mixtures. In 2018, more than 5000 tons of steel slag were generated in Ghana. A surge in SS quantity is expected, considering a 50 % increase in the number of steel factories in Ghana since 2018. HDPE, too, has shown great potential as a polymer modifier for bitumen, enhancing binder properties such as elastic recovery and adhesion. HDPE is estimated to comprise about 18 % of the one million tons of plastic waste generated in Ghana annually. Since SS and HDPE individually benefit asphalt concrete mixture properties, it is important to determine how their combined use as aggregate and bitumen modifier, respectively, will influence the properties of asphalt concrete mixture. This may promote the provision of more sustainable asphalt pavement while addressing the environmental concerns caused by the indiscriminate disposal of these waste materials. This study will explore the synergistic benefits of incorporating SS and HDPE into dense graded asphalt mixtures through a comprehensive laboratory evaluation.

Keywords: Waste, Recycling, Sustainability, Asphalt Concrete, Steel Slag, High-Density Polyethylene

Asphalt tack coating practices in Ghana

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Abstract
Tack coat (TC) is a thin layer of asphalt binder applied to the surface of an asphalt pavement layer before a new layer is paved. The TC is meant to help create a good bond between the two asphalt layers, ensuring good pavement performance and durability. An insufficient or excessive application rate of TC can lead to debonding, slippage, bleeding, rutting, and shoving of the asphalt layers. New, old, and milled asphalt pavement surfaces need different tack coat application rates to achieve adequate bonding. Unfortunately, TC application rate for different surfaces is not specified in Ghana's standard specification for road and bridge works. The document, instead, indicates that the TC application rate should be as stipulated in special technical specifications. The standard specification's lack of specificity regarding TC application rate may lead to variations in the country's TC application practices, potentially leading to excessive or inadequate application rates. A survey was conducted to understand the current tack coating practices in Ghana. The respondents, which comprised contractors, consultants, and engineers from government agencies, were randomly selected to ensure the survey results represented the entire road construction industry in Ghana. The results show differences in TC application rate practices. Therefore, it is necessary to develop an optimum application rate guidance for different asphalt pavement surfaces in Ghana.

Keywords: Tack Coat, Application Rate, Optimum, Bond

Development of a smart temperature control device for a biomass-solar assisted dryer

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Abstract
Issues related to high post-harvest losses and the seasonality of crop production requires developing innovative approaches for food preservation. The traditional open sun drying method of grains is the most practised preservative method among majority of smallholder grain farmers in Ghana though it is saddled with a lot of setbacks including grain contamination from dirt, pest, scavenging animals, and exhaust fumes of vehicles. Conventional drying methods that use fossil fuels are considered appropriate alternative, however, they are seldomly patronised due to the high operational cost. To address these challenges, a hybrid drying system that relies on renewable energy (solar and biomass) has been developed to meet the drying needs of smallholders. Nevertheless, temperature regulation in such systems is a concern. This study highlights the design and development of a smart temperature control device that integrates sensor technology, data analysis algorithms, and adaptive control strategies to optimize the energy efficiency of the biomass dryer. The experimental validation of the developed smart temperature system compared to a standard calibrated data logger showed a variation of approximately 2.37 $^\circ$C. This indicates the smart temperature control device has the potential to provide precise temperature regulation, conserving energy, and enhancing drying kinetics in the developed biomass dryer. This study underscores the importance of innovative solutions for sustainable agricultural applications.

Keywords: Smart Technology, Biomass-Solar Dryer, Temperature Control, Renewable Energy, Sustainable Agriculture, Innovation

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Identification of prospective aquifer domains within the crystalline basement rocks of Ghana utilizing the ground-penetrating radar

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Abstract
Aquifers in crystalline basement rocks develop in the weathered overburden and discrete fracture systems in the bedrock, making them very localised. The weathered overburden is not always thick enough to be reliable for rural water supply. On the other hand, the fracture systems can have better substantial yields; hence, the targets of groundwater exploration projects in this geologic terrain. Ground Penetrating Radar (GPR), a recent addition to subsurface geophysical exploration methods, has proven to be an effective way of delineating linear targets at depth. This study explores the potential of GPR as a supplement to the more common electrical resistivity tomography (ERT) and electromagnetic (EM) methods of groundwater exploration to improve drilling success rates. The GPR data from four localities underlain by the Kumasi granitic batholithic rocks using the Common-offset method with the 25 MHz unshielded antenna were used in this study. Three localities had boreholes (with available drill logs) intercepting the GPR transects, while the fourth site was a greenfield. A comparison of the analysed radargram revealed a favourable correlation with the borehole drill logs as two distinct features were observed –linear horizontal reflector at the top and strong sub-horizontal discrete linear reflectors at depth. The top linear horizontal reflector coincided with the interface between the weathered overburden materials, while sub-horizontal discrete linear reflectors were observed as fractures and water strike zones in the bedrock. This result showed that the GPR can be a reliable supplement to the commonly used groundwater exploration methods.

Keywords: Groundwater, Ground Penetrating Radar, Crystalline Basement Rocks, Fractures

Towards net zero internet of things system

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Abstract
As climate change continues to ravage the world, it is crucial to have a real-time flood monitoring Internet of Things (IoT) system. This system has the advantage of contributing to net zero, providing real-time data, and mitigating damages caused by flooding. This paper, undertaken as part of the author's MSc. in Engineering Business Management degree at the University of Sussex, presents the design and development of a prototype flood monitoring IoT system. Following a literature review of existing papers on different prototypes, the design of a flood monitoring IoT system was built considering its use case in Sierra Leone, bearing in mind cost and geography. The prototype design includes two Arduino ESP32 microcontrollers, two LoRa modules for data transmission, an ultrasonic sensor, a humidity and temperature sensor, a rain density sensor, and a soil moisture sensor. The use of mini solar modules to test the use case of clean energy with IoT as an energy-efficient solution is vital towards net zero. The codes of this prototype were sourced and edited. The results prove that the system works. There was limited testing; so, more data is needed to evaluate the accuracy and efficiency.

Keywords: Flood Monitoring, Internet of Things System, Net Zero, Sierra Leone

A comparative study of errors in coordinate transformation between Mine X local coordinates system and the Ghana National Grid and UTM systems

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Abstract
The challenges associated with datum transformation of a mine coordinate system from Ghana National Grid (GNG) and Universal Transverse Mercator (UTM) system persist as an urgent issue in numerous Ghanaian mines, which necessitates the implementation of pragmatic solutions. Accurate mapping of mine sites is indispensable for ensuring structural integrity, facilitating effective planning, and optimizing operational management within the mining industry. Consequently, it becomes imperative to meticulously evaluate the errors incurred during transformations between the mine's coordinate system and both the GNG and UTM systems. The primary objective of coordinate transformation lies in establishing a precise mathematical relationship between coordinates linked to diverse geodetic reference frames. This permits geospatial professionals in the mining sector the opportunity to seamlessly connect disparate datums. Focusing on a specific mine in Ghana, this study aims to scrutinize the errors inherent in coordinate transformation between local Mine X coordinate system and the GNG, as well as the UTM coordinate system, and to elucidate their repercussions on mining operations. In view of this, the present study utilised a 3D Conformal similarity model, specifically Bursa-Wolf model to derive transformation parameters. The residuals from the transformation results were assessed using root mean square of the errors and standard deviation. The outcomes reveal that the errors from transformation between Mine X and GNG is optimised as compared to Mine X and UTM. To this end, this study significantly contributes to alleviating the challenges associated with the selection of global coordinate systems for mines, thereby offering valuable insights to guide informed decision-making within the mining industry.

Keywords: Coordinate Transformation, Bursa-Wolf, Geodetic Coordinates, Geocentric Coordinates

Critical evaluation of cement quality in pre-construction: ensuring safety and resilient infrastructure development

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Abstract
The construction industry, a pivotal player in global infrastructure development, hinges on the quality of materials used, among which cement is fundamental. Cement, as the backbone of concrete structures, which dictates the overall strength and longevity of buildings and civil structures. However, the variations in cement composition stemming from diverse global sources of supplying cement plants in Ghana is seen to be problematic to concrete producers. This presentation is a comparative study of test results obtained on cement samples from clients tested at the Advanced Materials laboratory of Council for Scientific and Industrial Research - Building and Road Research Institute (CSIR-BRRI), with focus on compressive strength, water demand for standard consistency, fineness, setting time and soundness of the cement. It also presents case studies where negligence of cement testing had compromise safe usage of facilities and caused devastating economic loss to project contractors. Results of this study show that, compressive strength requirement of standard cement are not always met by cement samples, even though other parameters such as water demand, fineness, setting time and soundness could be attained well within standard specifications of the EN – 196. Nonetheless, these values obtained for each of samples differed from one other. Therefore, critical evaluation of cement quality by laboratory testing at pre-construction stage including fineness, consistency, setting time, and strength tests, are vital to ascertain its suitability for specific construction needs. It is recommended that comprehensive cement testing is done before construction as it is a fundamental necessity in construction, pivotal for ensuring structural integrity and resilient infrastructure development, cost-effectiveness, and environmental stewardship.

Keywords: Cement Quality, Compressive Strength, Fineness, Setting Time, Soundness, Structural İntegrity

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Synthesis of calcium silicate hydrate for use as an accelerator in pozzolan cement mortar

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Abstract
Researchers worldwide have shown considerable interest in synthesizing Calcium Silicate Hydrate (C-S-H) seeding in recent times. Utilizing C-S-H is recognized for its ability to accelerate the hydration process of Portland pozzolan cement, thereby reducing carbon emissions associated with cement usage. Blended pozzolan cement typically exhibits slower early strength development in contrast to pure Portland cement. Employing C-S-H is acknowledged for its role in improving the hydration kinetics of Portland pozzolan cement, consequently reducing carbon emissions stemming from cement usage. While blended pozzolan cement typically exhibits sluggish early strength development compared to Portland cement, the incorporation of C-S-H accelerates hydration kinetics and, thereby, enhances early strength performance. In this study, C-S-H was synthesized in the laboratory via the sol-gel process. Examination of the synthesized C-S-H through X-ray diffraction analysis revealed an approximate C-S-H content of 84 %. The study advocates for continued exploration aimed at devising efficient and cost-effective methods for large-scale C-S-H synthesis, essential for its widespread adoption.

Keywords: Pozzolan, Synthesis, Calcium Silicate Hydrate, Sol-gel

Enhancing the super capacitive performance of soot material induced with manganese cobaltite for supercapacitor application

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Abstract

The research introduces a cost-effective synthesis approach to produce a composite electrode using soot obtained from Tema Steels Limited, a local steel manufacturing company in Ghana. The composite electrode comprised treated thermally activated (TA) soot combined with annealed $MnCo_2O_4$ nanomaterial, using a facile hydrothermal technique. The fabricated electrodes were subjected to physicochemical and electrochemical assessments to analyse its chemical, structural, and electrochemical characteristics. To optimize its performance, the as-received soot was subjected to a 500 °C, 2-hour thermal treatment, effectively eliminating impurities and notably augmenting the specific surface area (SSA). The SSA increased from 869 m^2/g to 1064.89 m^2/g, a 22.56 % rise. The electrode's super capacitive performance was evaluated in a 3M KOH solution using a three-electrode setup. At a current density of 3 Ag-1, the composite electrode, comprising treated (TA) soot and annealed $MnCo_2O_4$, achieved a specific capacitance of 2818 Fg-1. The composite electrode demonstrated a cycling stability, retaining around 87 % of its capacity after 10,000 charge-discharge cycles in 3M KOH, establishing its practicality for supercapacitor applications.

Keywords: Binary Metal Oxides, Ternary Transition Metal Oxides, Spinel Structure, Hydrothermal Synthesis, Thermally Activated Soot, Energy Storage

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Capacitive performance of shea butter waste-derived hierarchical activated carbon: from supercapacitor to lithium sulphur battery application

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Abstract

A research hotspot from a sustainability perspective is the synthesis of hierarchically linked porous activated carbon from bio-waste for long-life and high-performance energy storage systems. In this work, carbonization and subsequent activation procedures were adopted to synthesize waste shea butter shells into oxygen-rich interconnected porous activated carbon (AC). The AC was used as an electrode for supercapacitor (SC) and sulphur anchor in lithium sulphur (LiS) battery to prevent polysulfide shuttling. The SAC_1.5 electrode material showed outstanding electrochemical performance and improved rate capability, owing to various synergistic effects originating from a high specific surface area (1233.5 m^2/g) and O-rich content. The SAC_1.5-based symmetric SC device delivered an impressive specific capacitance of 91.6 F/g with high energy and power densities of 12.7 Wh/kg and 375.1 W/kg at 0.5 A/g. The device also recorded outstanding capacitance retention after 10,000 charge-discharge cycles. It successfully lit an LED bulb for more than 1 hour, signifying the potential of bio-waste as an efficient carbon precursor for electrode material in practical SCs. When used as a composite for LiS battery cathode, a rate capability of approximately 1420 mAh/gsulphur was recorded at 0.1 C with high sulphur loading. The LiS battery delivered a 97 % capacity retention (with 99.4 % Coulombic efficiency) and powered a 3 V flameless candlelight for 10 hours after 200 cycles. This work offers an efficient, affordable, and environmentally friendly strategy for potential practical renewable energy storage devices.

Keywords: Shea Butter Shells, Hierarchical Porous Carbon, High-Energy Density, Supercapacitor, Lithium Sulphur Batteries

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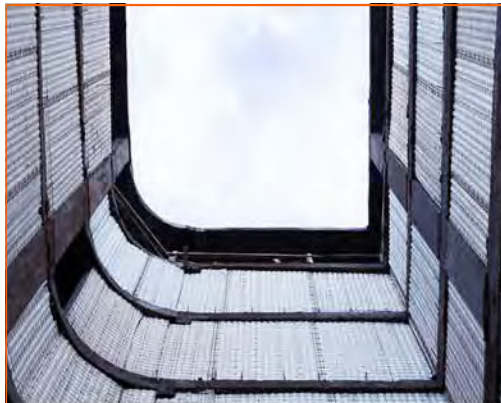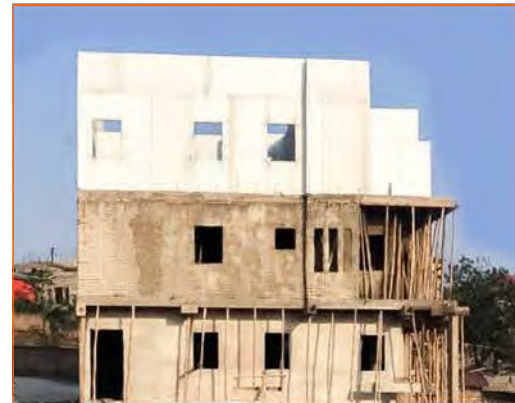
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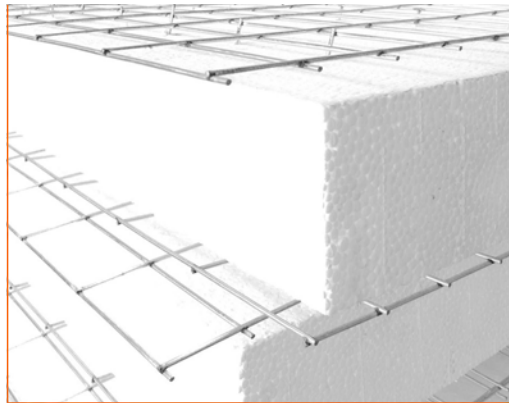
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