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Engineering in KENYA

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Roads and Housing

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Call for Papers

Engineering in Kenya Magazine - Issue 007

The Institution of Engineers of Kenya (IEK) publishes Engineering in Kenya magazine, whose target audience includes engineering professionals, practitioners, policymakers, researchers, educators and other stakeholders in engineering and related fields. The publication is distributed to its target readers free of charge through hard and soft copies.

IEK hereby invites you to contribute articles for the next and future editions. The articles should reach the Editor not later than April 10, 2022, for our next issue whose theme shall be "Energy" and related sub-themes across all engineering disciplines. An Article can range from engineering projects to processes, machinery, management, innovation, news and academic research.

The articles must be well researched and written to appeal to our high-end audiences and to be informative to the public in Kenya and beyond. The magazine reserves the right to edit and publish the article in line with its editorial policy. The articles should be "500-1000" words, font type "Times New Roman" and font size "12".

Send your article today and get a chance to feature in the magazine!

Send your article to:
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THE BIG 4
EMPOWERING THE NATION

KENYA VISION 2030

KeNHA
Kenya National Highways Authority
Quality Highways, Better Connections

ROADS FOR PROSPERITY

Roads play an integral part as a key enabler to the Big 4 agenda and the Vision 2030 growth objective. KeNHA is responsible for the development, rehabilitation, management and maintenance of a road network totaling 21,583 Kilometres.

- To date, the Authority has constructed 655.2 lane kilometres of roads under the regional integration and trade facilitation strategy
- 113.7 lane kilometres have been constructed under the national integration and accountability strategy.
- This has been achieved out of a total target of 2,282km of roads that were under construction during the year.
- KeNHA has made huge advancement in the implementation of the Performance Based Contracting (PBC) roads maintenance model and Corridor Management of the Road Network which has ensured timely maintenance interventions guaranteeing high service levels.

655.2

Lane kilometres of roads constructed under the regional integration and trade facilitation strategy

Over the year, the Authority has managed to:

- Maintain 15,676 lane kilometre under PBC
- Conduct routine maintenance of 11,905 lane kilometre of road

1. **Project Name:** South Sudan Link Road
Lot 4: Lokichar - Loichangamatak 40 Km
Lot 0: Loichangamatak - Lodwar 50 Km
Lot 1: Lodwar - Lokitaung Junction 80 Km
Lot 2: Lokitaung Junction - Kalobeiyei River 80 Km
Lot 3: Kalobeiyei River - Nadapal 88 Km

Benefits
. Facilitation of trade between Kenya and South Sudan
. Provide linkages for socio-economic activities and to town centres in the North-Western regions of Kenya such as Kapenguria, Marich Pass, Kainuk, Lokichar, Lodwar, Kakuma, Lokichogio and Nadapal.

2. **Project Name:** Merille - Marsabit (A2) Road
Year of Construction: 2013
Year of Completion: 2016
Length (Km): 121

3. **Project Name:** Nuno - Modogashe (A10/A13
Year of Construction: 2015
Year of Completion: 2020
Length (Km): 135

Benefits
. Support the development of Kenya's North Eastern province in achieving its full economic potential
. Improve the socio-economic welfare of its 1.4 million population

4. **Project Name:** Kenol - Sagana - Marua Improvement project
Year of Construction: 2020
Expected Year of Completion: 2023
Length (Km): 84

Benefits
. Reduced travel time
. Reduction of accidents along the road

5. **Project Name:** Nairobi Expressway Road Project
Year of Construction: 2020
Year of Completion: 2022
Length (Km): 27

Benefits
. Reduced travel time through Nairobi CBD
. Reduced traffic congestion along the A8
. 500 jobs created during operation and monitoring phase
. Enhance the economic vitality of Nairobi and consolidate Kenya's leading position as an investment destination in East Africa

6. **Project Name:** Kibwezi - Kitui - Migwani (A9/B64) Road
Year of Construction: August, 2017
Year of Completion: March, 2021
Length (Km): 192

Benefits
. This road offers alternative route from the port of Mombasa to the Lower and Upper Eastern regions, as well as Ethiopia hence decongesting the Nairobi - Mombasa highway
. Increasing the economic competitiveness of the lower eastern regions
. The road has reduced the travel time between Kibwezi - and Kitui, as well as enhancing interconnectivity between the various towns it traverses through

7. **Project Name:** Mombasa Port Area Road Development Project (MPARD)
MPARD Package 1: Dongo Kundu (Miritini - Mwache - Kipevu Link) Road
Length (Km): 10.1

Benefits
. Reduced travel times between Mombasa and Kwale county
. Reduced traffic congestion through Mombasa City

8. **Project Name:** Eldoret Town Bypass
Year of Construction: 2017
Year of Completion: 2022
Length (Km): 32

9. **Project Name: Lot 1:** Isebania - Kisii (A1) Road
Year of Construction: 2017
Year of Completion: 2021
Length (Km): 163.5

10. **Project Name:** Kisumu - Kakamega (A1) Road
Year of Construction: 2013
Year of Completion: 2020
Length (Km): 46.5

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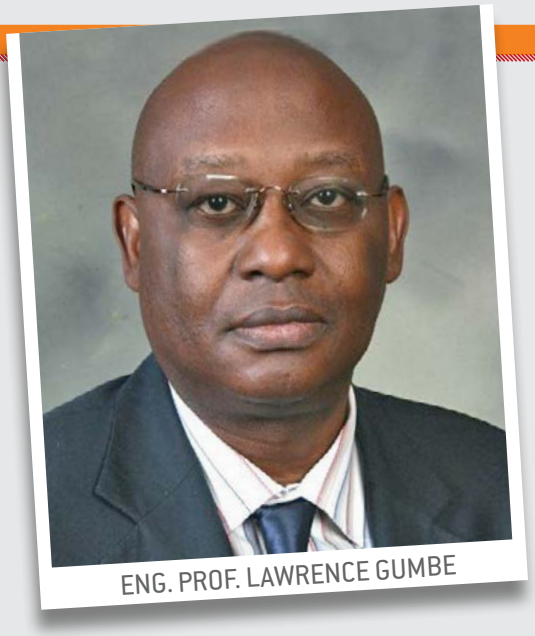


ENG. PROF. LAWRENCE GUMBE

Roads and Housing Key in Stimulating Economic, Social Development

ROADS have contributed immensely to economic development and growth in the modern world. They have brought important social benefits to society. They are of vital importance in order to make a nation grow and develop. In addition, roads provide access to employment, social, health and education. Therefore, the road network is crucial in fighting against poverty.

Roads open up more areas and stimulate economic and social development. For those reasons the road network is one of the most important of all public assets.

According to the ***Kenya Infrastructure Report Card, 2021,*** Kenya is ranked 60th in terms of road quality according to the ***Global Enabling Trade Report 2016.***

The report noted that it is not economically sustainable to maintain a large unpaved road network.

> The total length of paved roads per 1,000 inhabitants in Kenya was 21.9km, which is less than the EAC member countries' average of 25.3km.

The report recommended that roads be upgraded to paved standards to create a reliable and resilient road network and to minimise maintenance costs in the long term for sustainability. In its analysis, it is noted that the Kenya Roads Board undertook Road Inventory and Condition Surveys (RICS) in 2009 and 2018.

From the 2018 RICS, road network conditions for both county and national trunk roads improved over the 10 years. In summary, 46.17 per cent of all the classified paved road networks were in good condition, 40.22 per cent in fair condition, 10.62 per cent in poor condition while 2.99 per cent were under construction. Some 14.54 per cent of the classified unpaved networks were in good condition, 46.91 per cent in fair condition, 36.71 per cent were in poor condition while 1.83 per cent were under construction.

Thus, the report noted that 73.92 per cent of all the classified roads were in maintainable state whereas 26.08 per cent are either dilapidated and require reconstruction or are under construction.

The ***Kenya Sessional Paper No 3 of 2016 on National Housing Policy*** expects the country to ensure progressive realisation of the right to accessible and adequate housing and reasonable standards of sanitation for every person as per ***Article 43 of the Constitution***.

Housing is one of the basic human needs besides food and clothing. It is considered as one of the most basic human rights and an essential component of the right to an adequate standard of living.

Further, adequate and affordable housing is not only necessary for security and comfort, but also critical in fostering social cohesion and development of a nation.

According to the above sessional paper, households who live in extremely inadequate housing conditions characterised by poor structural conditions, inadequate basic services, insecure tenure, and inadequate space and privacy live predominantly in slums and informal settlements in urban areas.

However, such households are also found in rural areas. Estimates by Kenya National Bureau of Statistics (KNBS) for the period between 1999 and 2009 indicate that households in extreme housing deprivation increased by 31 per cent from 889,696 to 1,166,138 (which translates to 13.3 per cent of total households), while those in some form of deprivation increased from 3,368,135 to 4,454,121 (50.8 per cent of all households) over the same period. This is an indication of the need for State intervention, particularly for the low-income segment of the population who live in extremely inadequate conditions.

The Constitution affirms this in Article 21, which provides that "the State shall take legislative, policy and other measures, including the setting of standards, to achieve the progressive realisation of the rights guaranteed under Article 43."

In order to give effect to this constitutional provision, the National Housing Policy aims at reducing the number of households living in extremely deprived housing conditions by half in the next five years.

This issue of ***Engineering in Kenya*** has informative, educative and entertaining articles on roads and housing. We hope that we will meet your expectations.

This issue also marks the first anniversary of ***Engineering in Kenya***. The ***Editorial Board*** is very grateful to the IEK Council, IEK members, our contributors, our readers and our advertisers for the invaluable support they have given to us in our maiden year. We promise to try harder to improve the publication.

We also wish all engineers who will be seeking public office in the General Election in August this year all the best! We hope that more engineers can join Parliament, county assemblies and other elective offices at all national and county levels so that we can have champions of causes dear to engineers.

Editor.


ENG.NATHANIEL MATALANGA

Let's Stay United Behind Issues Core to the Engineering Profession

WELCOME to the sixth issue of Engineering in Kenya magazine. The Institution of Engineers of Kenya (IEK) celebrates what has been an eventful year. This past year we have witnessed remarkable progress on many fronts. We have witnessed the launch of Engineers Stamp by Engineers Board of Kenya (EBK). This is a significant milestone in the quest to establish engineers' identity.

In the policy space, we have worked to ensure scales of fees are printed by the Government Printer for presentation before parliament by the Cabinet Secretary, Transport, Infrastructure, Housing and Urban Development. Our participation in international engineering deliberations continues to strengthen professional collaboration and linkages. This March, I have been leading a team of The Institution of Engineers of Kenya delegation to the World Federation of Engineering Organizations (WFEO) World Engineers Summit and General Assembly in San Jose, Costa Rica.

It is absolutely important that the engineering fraternity stays united behind issues core to our profession. Over the past year, we have been in the frontline advocating and defending the professional engineering space. The Institution of Engineers of Kenya (IEK) and the regulator – Engineers Board of Kenya (EBK) – have worked very closely in matters related to the profession as well as its industry and academia advancement. These efforts have borne fruit, as witnessed in the fight against the assault on engineering-related jobs at State agencies.

> We celebrate the wisdom of the National Assembly in setting aside a Bill brought before the august House that sought to remove engineering experience as a prerequisite for appointment to head roads agencies in Kenya. One of our wins also includes the advisory issued by the State Corporations Advisory Committee (SCAC) that reaffirmed the need to keep engineering jobs in the jurisdiction of professional engineers.

Over the last two years, IEK has been fighting for professionalism in engineering on many fronts. We strongly advised against separating project financial audits from technical audits. From an engineering point of view, the two audits are one and inseparable. We must advocate for State agencies to recruit competent engineering professionals, who are capable of overseeing both technical and financial implications of projects and policies being undertaken. It is only professional engineers who are able to guide technical policies that touch on core mandates of parastatals and agencies to which they are appointed.

As an institution, we have restarted Engineering Excellence Awards to appreciate and promote high-level engineering excellence and professionalism. For Kenyan engineers, there exists a great deal of engineering opportunities locally and abroad, which will become more evidently pronounced when the EBK signs up to the Washington Accord.

IEK elections are coming up. I would like to appeal to selfless Engineers to offer themselves as candidates in the elections, so as to take up leadership positions in the institution. It is important that the Institution is led by forthright, forward-looking Engineers, who will appreciate that service to the Institution of Engineers of Kenya is majorly a personal sacrifice, with limited material reward. The electorate must be aware of people seeking office for personal gain.

That said, I wish to assure engineers who will be elected to serve that they will derive plenty of personal satisfaction for their services rendered to fellow engineers, in terms of moving the profession and development in the country forward.

I believe there are also very competent and capable members who have served before, who may wish to still offer themselves to continue in leadership service to the Institution. I urge the engineering fraternity consider them if they express their wish to continue serving. Those who have served before must clearly state their achievements so that voters can exercise the wisdom of discernment for the benefit of IEK.

Candidates running for office must understand that you will need to create plenty of time away from your busy schedules to effectively serve the IEK. Leadership is a matter of personal sacrifice. All candidates must contest fully aware that there is little material gain. The team that takes charge at the helm after elections must be prepared to take the Institution to the next level. Elections are a contest. Prepare to lose as much as you prepare to win. Wishing you success!


ENG. MARGARET OGAI

Message from IEK Honorary Secretary

WELCOME to this sixth issue of Engineering in Kenya Magazine. I would like to take this opportunity to celebrate our resilient engineers and their contribution to roads and housing development in the country. The Institution of Engineers of Kenya (IEK) membership has over the years demonstrated highly specialised skills in policymaking, frontline leadership in the building of our national highways and bridges, hydrology engineering, planning, design and construction supervision. This edition acknowledges their great skills.

The Institution also lauds the structured training currently being offered by Kenya's roads agencies to graduate engineers. This training will help us grow a reliable engineering workforce, for our rapidly expanding national infrastructure network. Roads and housing are important aspects of our lives, and Engineers play an important role in the construction of the two.

Roads connect us to the world. They lead from our doorsteps and allow us to go out, meet other people, earn our livelihoods and return to our homes. Reliable, safe housing structures must continually be engineered as safe places where we can sleep, eat and interact with kith and kin. Structural integrity of roads and bridges also remains key.

Currently and in the recent past, we have seen the development of superhighways and road networks in Kenya through concerted efforts of the national government. Counties have been hard at work to upgrade their road networks and this is definitely a boost for our agricultural sector.

Housing, on the other hand, has particularly been a core pillar of the national government's Big 4 Agenda, ranking high in our priorities as a country, now and in the foreseeable future. Concerted efforts have been made by the government to ramp up affordable housing. The State has a raft of plans in place to provide about 225,000 low-income units for the low-income sector.

This sixth edition of the magazine delves into some of the opportunities for engineers in the projects in the housing and roads sectors, and seeks to explore ways in which engineers are contributing to the infrastructural development in the country. We examine, for example, the development of the Bus Rapid Transit (BRT) system, which is aimed at decongesting our roads and highways and providing fast access in and out of Nairobi's central business district (CBD). There are also articles on infrastructural development in the counties, the development of industrial parks and what the Presidential Delivery Unit is doing with regard to infrastructure projects.

Our institution is keen to see progress of members in these and other sectors, not only for the increased employment opportunities they will bring to local engineers but also for the contribution it will bring to innovation and development in the country. We also hope our members can benefit from transfer of technology and knowledge in some of the large projects being undertaken by foreign engineers, so that we can develop our local capacity to develop and manage our infrastructure.

Finally, we want our investments as a nation to last. We have seen the loss of lives due to bridges that are poorly constructed, houses that cave in and other similar issues. These are matters that touch on the professional integrity of the engineer and the IEK is willing to offer technical support to counties and in collaboration with government regulators in order to ensure these incidents are a thing of the past. We particularly want to work closely with county governments where these issues arise frequently, to raise up the standards of procurement, planning and inspection so that works are fit for purpose.

I wish you an insightful read.

Infrastructure Development as Foundation of Sustainable Development

By Dato' Ir. (Dr.) LEE Yee Cheong, BE Hons (Adelaide), Hon. Doc Eng (UNITEN), DPMP, KMN, AO

THE two greatest global challenges are poverty eradication and climate change mitigation. The foundation to meet the above challenges for the developing world is comprehensive and inclusive physical and virtual infrastructure development. Engineers and engineering are key.

The first success was the four Asia Tiger economies of Hong Kong, Korea, Singapore and Taiwan in the 1990s, followed by ASEAN countries like Malaysia and Thailand and more recently Indonesia and Vietnam. The outstanding example is China whose comprehensive and inclusive physical and virtual infrastructure is world renowned. China has not only lifted 800 million of her people in 2021 out of poverty but also joining the Chinese society of moderate prosperity.

The first prerequisite for successful infrastructure development is long term political vision and will at the very top. China has been following the Reform and Opening Up Policy of Deng Xiaoping since 1979. China's top leaders have predominantly been engineers. Current President of China Xi Jinping, a water resource engineer, is also sharing China's social and economic success with the developing world through the Belt and Road Initiative (BRI).

Malaysia's infrastructure development has been underpinned by her Vision 2020, and Kenya by her Vision 2030. The author was the catalyst for the National Social and Economic Council Kenya (NESC) to work on Vision 2030. In NESC, the author had urged Kenyan policy makers to look East to Asia and Malaysia.

The second prerequisite is abundant engineering human resources. China graduates more than one million engineers and technologists every year. In this aspect, most developing countries are desperately lacking sufficient number of engineers and technologists to drive infrastructure development in their countries.

The author has been working to increase the availability of indigenous competent engineers and technologists in the FAEO/FEIAP (Federation of Engineering Institutions in Asia and the Pacific) programme to get African engineering education qualifications to international standards. The programme is termed Africa, Asia and Pacific Accord (AAP). In order to achieve the objective of mobility of engineers across Africa, the author has proposed that FAEO gets the African Union Commission to initiate the African Accord.

Under the FAEO MOU with the Institution of Engineers (India), the author has been matchmaking FAEO with the Engineering Staff College of India (ESCI) to set up similar pilot engineering lifelong training centres in Harare and Kigali under seed-funding from the India UN Development Partnership Fund.

More recently, the author has approached Chinese university management colleagues to consider alleviating the critical shortage of engineers and technologists in the South by forming a corps of Chinese engineers experienced in infrastructure development to work as infrastructure project managers in the developing world. The curriculum and post graduate experience of the proposed diploma or degree course in infrastructure engineering will be based on BRI.

Academician Dato Ir. (Dr) Lee Yee Cheong, Malaysia, Hon Chairman, UNESCO International Science Technology Innovation Centre for South-South Cooperation (ISTIC)/Commissioner, UN Broadband Commission/Advisor, Federation of African Engineering Organisations (FAEO)/Former President, World Federation of Engineering Organisations (WFEO)/Former Member, National Economic and Social Council Kenya (NESC)

Regulating the Engineering Value Chain

Speech By Engineers Board of Kenya Chairman Eng Erastus K. Mwongera, CBS, CE, FIEK

> ...the Board is working to fast-track the registration of professional engineers to correct the ratio of professional engineers to graduate engineers.

It is my warm pleasure to welcome you and to join you at the 2021 Institution of Engineers of Kenya (IEK) International Conference. This year, I don two hats, one as the Chairman of the Engineers Board of Kenya (EBK) and the other as the Chairman of the IEK Conference Committee which has been responsible for all the preparations. I want to congratulate IEK for consistently organizing this conference over the years without fail, even last year when everything seemed so uncertain. Sometimes, one doesn't truly appreciate the work that goes into such an event until one takes charge behind the scenes as I have done this year.

Our theme this year '***Engineers Accelerating Sustainable Economic Recovery'***, is one that we as EBK are proud to be associated with as a long-standing organising collaborator of this conference. It provides an opportunity for engineers and associated professionals to share experiences and knowledge gained during a difficult time. The pandemic was a moment of trial but as we all know; crisis situations also lead to tremendous growth. The other theme is the one chosen by the 4th Women Engineers Summit 'Power of Diversity.' We at the board are painfully aware of the low numbers of women engineers and continue to champion their growth in the profession.

This is therefore an opportunity for us to reflect on this topic once again and see how we can tip the scale to a more balanced gender distribution. As you know, the Board is mandated to effectively regulate the entire engineering value chain comprising of education, training and engineering practice. To achieve this, the Board has been carrying out several programs aimed at strengthening the profession. We cannot do this in isolation, so we work closely with other regulators in the built environment such as the National Construction Authority (NCA) and the Board of Registration of Architects and Quantity Surveyors (BORAQs).

We also partner with private sector to train graduate engineers to be work ready. Our alliance with companies such as ISUZU and Schneider Electric, who I am happy to note have also taken a keen interest in our conference, is a testament to this ongoing work. I would be remiss if I failed to commend registered professional engineers who have contributed their time to mentor graduate engineers, which is such an important part of our professional growth.

Registered members have been eager to participate in various mentorship programs. Across the borders, the Board has been pursuing mutual agreements and partnerships such as the Washington Accord and the East Africa Community (EAC) Mutual Recognition Agreement (MRA). This will promote mobility of engineers to practice in the region once various trade treaties are in place.

As another priority, the Board is working to fast-track the registration of professional engineers to correct the ratio of professional engineers to graduate engineers. In the next five years the Board targets to register 10,000 professional engineers and has put in place mechanisms for ensuring a smooth and effective transition from graduate engineer to professional engineer. Our recent online workshops are an open engagement guide on the transition process. Our mode of delivering of programmes has also shifted largely from 'in person' to virtual for our continuing professional development programs and this has in turn improved the transition rate of graduate to professional categories. In tandem to this, we have sensitized the public on guidelines for use of engineering stamps and the engineers' scale of fees.

I wish to assure all our stakeholders that the Board is enhancing its service delivery in order to accomplish the array of programs we have planned for Engineers and one of the ways we are doing that is by the strengthening the core of our operations, our secretariat.

Rural Road Networks Leading Kenya on the Path towards Economic Growth

(Photo Courtesy)

By EiK Correspondent

KENYA'S Gross Domestic Product (GDP) is set to rise by an estimated five per cent, following the completion of newly tarmacked rural roads. This is according to a paper presented by Kenya's leading engineering experts, led by Eng Philemon Kandie, at the 28th Annual International Engineers Conference organised by the Engineers Board of Kenya (EBK) and Institution of Engineers of Kenya (IEK) in November last year.

New roads have been recently tarmacked in many rural areas in Kenya, thereby improving access to resources and services. In 2013, the government set out elaborate plans to construct about 10,000km more of roads across rural Kenya in line with the Kenya Roads Act 2007. Subsequently, the Kenya Rural Roads Authority (KeRRA) was founded and tasked with delivering 8,900 new tarmacked rural access roads.

"Kenya has since completed 4,349km more of newly tarmacked rural roads. Through rapid rural areas infrastructural expansion, we are on track to realise real significant GDP growth in rural Kenya. Access to resources and services has tremendously improved in areas where KeRRA has completed road projects under the R10,000 Low Volume Sealed Roads project," says the conference paper.

> Most of the roads in rural Kenya are either in earth or gravel standard. The national government has been hard at work seeking to make rural areas accessible and with enhanced mobility. To enhance the growth of the primary sectors of the economy, the Low Volume Sealed Roads programme seeks to improve 10,000km of rural roads to bitumen standard, over a period of 10 years that started in 2014.

The R10,000 Low Volume Sealed Roads programme has since led to new roads in prehistoric sites like Koobi Fora, Lake Turkana, Lake Turkana Wind Power (LTWP) farm, Ndoto Mountains in Ngurunit and Chalbi Desert, among others, greatly boosting tourism and economic prospects of the regions.

The programme has also delivered rural roads running from Malindi to Salagate, the Tsavo East, Lunga Lunga, Shimoni, Samburu, Kinango to Shimba Hills, completing the coastal circuit. In Western Kenya, Sori-Mbita road has been completed, improving access to the Ruma National Park.

The programme has also witnessed completion of rural road works between Mariakani, Bamba and Kilifi, Baricho and a bridge supporting the Galana-Kulalu irrigation project in Tana River County.

Kenya's R10,000 Low Volume Sealed Roads Programme has also delivered rural roads spanning Isara-Imaroro-Kajiado-Kiserian-Ngong-Suswa, opening up the much needed alternative route to the Northern Corridor for lighter traffic.

On December 12, 2017, President Uhuru Kenyatta announced the 'Big Four' development agenda focused on uplifting the standards of living of Kenyans on the path to becoming an upper middle-income country by 2030.

"Rural roads are one of the key enablers of economic growth and have productive inter-linkages with other socio-economic activities/centres such as industrial, services, agricultural, commercial, social institutions and households," said Eng Kendie, who is the KeRRA Director General.

"As such they are critical enablers in the realization of the "Big Four" Agenda and sustainable development."

The newly tarmacked rural roads have been crucial in facilitating the last mile electricity connectivity, greatly improving farm to market access for farm inputs and outputs, besides creating employment in rural areas where construction works are underway.

The conference paper also revealed that KeRRA has been working closely with county governments to ensure all rural roads leading to health facilities are accessible at all times.

Experts say continued expansion of rural road networks is poised to open up devolved Kenya to access to raw materials for manufacturing and value addition, and easing transportation of processed goods. Road access to areas perceived as affordable housing destinations has greatly improved prices of land in the last few years.

KeNHA DG Eng. Kung'u Ndung'u: We are Opening up this Country, One Highway at a Time

KeNHA Director General Eng Kung'u Ndung'u (centre) with IEK Editorial Board Secretary Eng Paul Ochola and Council member Eng Grace Kagondu.

1. What is the core mandate of the Kenya National Highways Authority (KeNHA)?

KeNHA is a State corporation mandated to develop, construct, and maintain national roads Class A, B and S.

2. Share with us the scope of some of the highway road projects KeNHA is currently undertaking around the country.

Some of the key projects that the Authority is currently working on include the nearly completed Nairobi Expressway, Mau Mau Road, Makupa Causeway Bridge in Mombasa, South Sudan Link Road, and Mombasa Port Area Road Development Project (MPARD).

Other game changer projects that are expected to commence this year are the Horn of Africa Project running from Isiolo to Mandera and the Nairobi-Nakuru-Mau Summit Project that will be implemented under the Public Private Partnership model.

3. What are the completion timelines and status of the ongoing road projects?

Construction of the Nairobi Expressway continues to make good progress, with a completion status currently standing at 82 per cent. The project is on schedule for opening to the public by March 2022.

The construction of the Makupa Causeway Bridge is currently at 50.39 per cent completion. It is expected to be completed this month. On the other hand, the Mau Mau roads are expected to be complete in 2023.

The MPARD package three (3) is at 90 per cent with an earlier completion date of July 2021. However, there is Extension of Time (EoT) under review. The MPARD Package two (2) is expected to be completed in March 2024 and its physical progress stands at 44 per cent. The MPARD package one (1) is complete and open to the public for use.

The MPARD project will connect Mombasa Island to the South Coast and with the development of the Special Economic Zone, the East African economy will open up the Coast region.

4. In your assessment, what overall impact would you say these projects have or will have in terms of economic fortunes in the medium and long term for the areas they are in?

The Nairobi Expressway is expected to bring the much needed relief to traffic congestion in the city. It is also a source of employment both during and after construction.

The Makupa Causeway Bridge and the Mau Mau roads will open up the areas for development. The value of property along the routes where these roads are being constructed have appreciated in value and transportation of tea to the market has been made easy.

5. The Nairobi Expressway has been lauded as a game changer. How will it transform traffic flow in the city?

It currently takes motorists about two hours to commute through Nairobi during rush hours. Available data indicates that through such traffic jams, Kenya loses approximately Ksh18 billion annually. The Nairobi Expressway, therefore, will significantly reduce the time spent on the road from two hours at rush hour to between 10 and 15 minutes.

This is expected to significantly reduce vehicle running costs. Other benefits include reduction of carbon emission as vehicles will not be staying unnecessarily too much on the road due to traffic.

6. When can the city residents expect total completion and return to normal traffic flow on the highway?

The Nairobi Expressway is set to be open to the public by March this year. This means that by June 2022, everything is expected to have normalised and any pending work fully finalised, with traffic flow streamlined.

7. *Infrastructure vandalism has been in the limelight lately. As an agency, what are your experiences?*

Vandalism has been a challenge to players in this sector. We are doing our best in making sure that our road furniture is protected by creating awareness on social media against vandalism, ensuring that the perpetrators are arrested and charged.

Recently, the President banned the market for scrap metals. This, we believe, will go a long way in reducing vandalism.

8. *Some experts say in dualling major highways lies the answer to stemming runaway road accidents in the country. As an agency, is dualling of major highways part of the long-term strategy?*

Dualling of roads helps reduce congestion in roads but it is not a sustainable way to reduce accidents. Enhancement of road safety measures, enforcement of traffic rules and sensitising road users are some of the ways that can help stem accidents.

9. *In regard to the quality of engineering graduates, there has been an outcry that the universities are churning out graduates that are lacking in various competencies. What can you comment on this?*

The Authority has an active Graduate Engineer Training Programme, which has allowed graduating engineers to gain work experience and skills that are critical to the development of the sector.

The Authority is doing its best in empowering these young engineers through the Programme in a bid to bridge the existing gaps and mismatch between academia and the industry. Through this programme, the graduate engineers are equipped with the skills they require in the actual work environment.

10. *What notable challenges exist in pursuit of the mandate of such a critical roads agency as KeNHA?*

First, our greatest challenge is funding gaps and deficits. It is our goal to have all the roads under our purview, measuring approximately 21,000 kilometres, tarmacked with appropriate safety features.

The second one is overloading by heavy commercial vehicles. We have invested heavily in axle load control and we appeal to truck drivers and owners to observe both axle and gross vehicle weight limits.

Finally, there is the issue of vandalism of road furniture, including signs and guardrails, which we have already discussed above.

11. *What strategies does KeNHA employ to address these challenges?*

The financial challenge has been eased by Public Private Partnership (PPP) model of financing the building of roads. This is a funding model where the public partner is represented by the government at a local, State or national level and the private-sector partner assumes all risks. One of the projects funded through this model is the Nairobi Expressway.

12. *In the spirit of Buy Kenya, Build Kenya, how does the agency promote local engineering contractors?*

When bidding for the Government of Kenya (GoK) funded projects, the local contractors have a 20 per cent advantage of quoting over foreign bidders, which is protected by law.

KeNHA is also encouraging more projects to be undertaken as joint ventures. Indeed, 100 per cent of road maintenance projects by KeNHA are awarded to local contractors. These contracts provide opportunities for budding local contractors to gain experience.

Economic Importance of Kenya's Road Infrastructure Network

By Eng. James Kung'u

ROAD infrastructure plays a major role in the movement of goods, services and people in the economy. Road transport accounts for over 90% of all passenger and freight movement in Kenya. Good roads translate to efficient service delivery, global trade competitive advantage (exports and imports) due to reduced transport costs. Other advantages of a good road network are improved livelihoods, linking up of production to distribution, access to healthcare, access to markets and social and cultural integration.

The Classified Road Network is about 161,000km with an estimated asset value of KES. 3.5 trillion. The management of the road network in Kenya is as stipulated in the 4th Schedule of the Constitution of Kenya, 2010: under the National Government for the National Trunk Roads (which is about 40,000km) and the County Governments for the County Roads (about 120,000km). An additional unclassified network of about 80,00km falls under what is referred to as "Narrow Roads" category which means they have a right of way of less than 9m.

The Ministry of Transport, Infrastructure, Housing, Urban Development & Public Works is overall responsible for setting standards, guidelines and overarching policies to guide the development, maintenance and rehabilitation of the entire road network.

The institutional arrangement for the management of roads is as follows:

- Roads Division is responsible standards, M&E and oversight.
- Materials Testing and Research Division is responsible for testing and research on materials used in road construction and other infrastructure.
- Mechanical and Transport Division is responsible for provision and management of the mechanical, transport and plant services in the country.
- Kenya Institute of Highways and Building Technology (KIHBT) is a skill improvement training center for the infrastructure sector.

The key implementing agencies for national roads were established under the Kenya Roads Act of 2007. These are Kenya National Highways Authority (KeNHA), Kenya Rural Roads Authority (KeRRA) and Kenya Urban Roads Authority (KURA). In addition, the Kenya Roads Board (KRB) established under KRB Act of 1999, works primarily to fund the maintenance of the road network in the country through the Road Maintenance Levy Fund (RMLF).

The Roads sub-sector is key in facilitating achievement of the Kenya Vision 2030, through the Medium-Term Plans (MTP) and the Big Four Agenda. Internationally, it is immensely contributing to achieving the United Nations Sustainable Development Goals (SDG) by helping in achieving SDG 9 aimed at building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation, which is an enabler for achieving the other SDGs. At continental level, the road sector is key to achieving the AU Agenda 2063, goal no 10 which aims to have world class infrastructure criss-crossing Africa. At the regional level, the sector is aligned to the infrastructure development pillar of the EAC Vision 2050.

Over the last nine years, a total of over10,400km of roads have been constructed and completed. A total of 3,096km were completed during 2013 -2017 period (MTPII) while 7,338 Km were completed during 2018-2021 period (MTP III). In addition, more than 6,600km are ongoing road projects.

Key road corridors have undergone capacity enhancement and rehabilitation to meet the present and projected future traffic needs in the country and the region. This has been enabled by funding from the GOK exchequer and through partnerships with multilateral development agencies and financing institutions like the World Bank, EU Agencies, JICA and African Development Bank (AfDB). Some of the key programs include:

Roads 10,000 Programme (Low Volume Sealed Roads)

This concept was conceived in the Financial Year 2014/2015 and the initial contracts were awarded in January 2016. The programme is fully funded by the GOK. As at end of 2021, the programme is being implemented in 45 Counties, with over 4000 km having been completed under this program, while another 4000km are currently under construction. These roads have opened up all corners of the country making accessibility to services easier for all citizens especially those from regions which were under developed.

The programme is expected to improve the Rural Access Index (RAI) which is among the most important global

indicators for measuring people's transport accessibility in rural areas. RAI was endorsed by the World Bank's Transport Sector Board in 2003 and provides strong linkage to the Sustainable Development Goals (SDGs) and a consistent basis for estimating the proportion of the rural population which has adequate access to the transport system.

Construction of Bypasses

Construction of the Nairobi Western Bypass (Kikuyu – Ndenderu - Ruaka) is ongoing, which will complete the bypasses around the Nairobi city. Dualling of Eastern Bypass (Cabanas – Ruiru) is ongoing while the Northern Bypass (Ruiru – Ruaka) is planned for dualling.

The Mombasa Southern Bypass (Dongo Kundu) is ongoing which once completed will improve the connection to South Coast and beyond to Tanzania through Lunga Lunga without using the ferry (Likoni).

Construction of Bypasses in other towns include: Kisii Bypass; Thika Bypass; Meru Bypass and Eldoret Bypass.

Improvement of Roads in Cities, Urban Areas and Municipalities

A good number of projects that aim at improving the flow of traffic in urban areas have been undertaken. For instance, in Nairobi City, the Construction of Valley Road/Ngong Road/Nyerere Road Interchange and Upper hill overpass is ongoing. The dualling of Ngong Road from Kenya National Library to Dagoretti Corner is complete while Dagoretti Corner-Karen Roundabout section is ongoing. Outside Nairobi City, upgrading of urban roads has been completed in various Counties, for example Kitale township roads, Kapenguria township roads, Nakuru CBD roads, Mokowe township roads (Lamu), Wajir and Isiolo among others.

Lamu Port South Sudan and Ethiopia Transport Corridor (LAPSSET) Project

This is a multi- modal transportation program that seeks to connect South Sudan and Ethiopia to the East African Port of Lamu and has Roads as one of its major components in the infrastructure corridor. The roads under this project are the Lamu Port Access Road (which is complete), Garsen-Witu-Lamu Road (about 96% complete), Lamu – Ijara – Garissa – Isiolo Road, Isiolo – Moyale (complete) and Isiolo-Lokichar-Nakodok roads. Stage construction has already started on the Lamu – Ijara – Garissa section while Lokichar – Lodwar – Nakodok is almost complete under the South Sudan Link project.

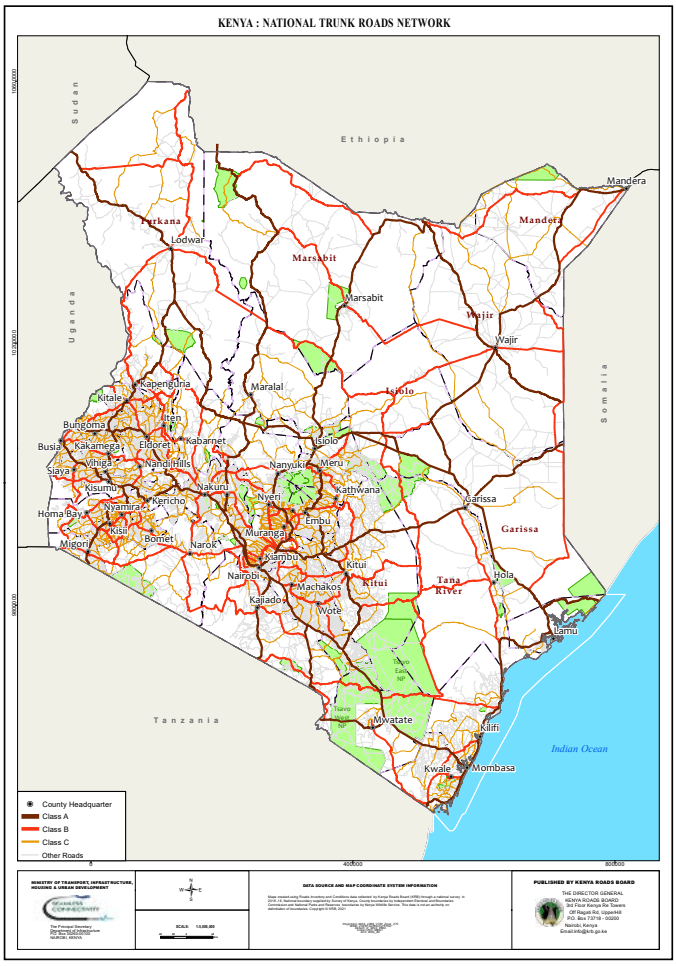
Horn of Africa Gateway Development Project (HoAGDP)

Upgrading to bitumen standards of the Isiolo-Mandera corridor (740km) under HOAGDP is set to start soon, with the first section between Isiolo to Modogashe (about 190 Km) currently at advanced stage of procurement. This is one of the high impact projects which once implemented will not only open the Northern and North Eastern region of Kenya but also transform the region economically and socially. Funding for the whole road has already been secured.

PROJECT FINANCING

The financial demand for road infrastructure developments cannot be adequately met through Government financing given the current economic situation, thus a huge financing-gap prevails. The Government therefore has started to look at alternative ways of infrastructure financing such as through Public-Private Partnerships (PPP); with focus on demonstrable value for money and public benefits for such partnerships.

Through the PPP programme, the construction of the Nairobi Expressway is ongoing while the commercial agreement for Nairobi – Nakuru – Mau Summit project was signed in 2020, and other conditions precedent for a financial close to be reached are at advanced stages.



Eng. James M. Kung'u
Chief Engineer, Roads
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Utilising Geothermal Resources for Direct Uses

By Evans Mutai, GDC

The Geothermal energy has far much more uses than the generally known production of electricity. Electricity, thermal energy, water, minerals, and gases are all products of geothermal energy development. In Kenya, geothermal energy is mostly used for electricity generation, but large potential exists for Direct Uses.

Direct Use refers to the use of geothermal energy for other purposes other than electricity generation. Thermal energy can be used for various processes in agriculture, industrial processes, tourism, drying and post-harvest value additions. Temperatures as high as 180 degrees Celsius can be obtained as a by-product of electricity generation and can be cascaded to various uses to ensure efficient utilization.

In Kenya, the Direct-Use technology has seen marginal uptake with a handful of organisations exploring this minimally charted territory to set up Direct-Use projects. Oserian Development Company is one of them, utilising geothermal energy to heat greenhouses thus boosting the growth of their produce while also fighting off fungal infections on their flowers. Research has shown that using greenhouse heating increases crop yield while also ensuring that the crops are grown organically devoid of the harmful greenhouse pesticides.

A capsicum harvest from the geothermal heated greenhouse in Menengai

In 2015, the Geothermal Development Company (GDC) set up a pilot Direct Uses projects, mainly in agriculture, with an aim of demonstrating and marketing the technology.

The demonstration unit, located in the Menengai Geothermal Project, consists of five small projects namely geothermally heated greenhouse, fishpond, geothermal powered laundromat, geothermal milk pasteurizer and a grain dryer.

Tests conducted by the GDC DU Department in the demonstration units have ascertained the commercial viability of the demonstration projects. For instance, the geothermal grain dryer and the milk pasteurizer offer a competitive alternative to the expensive high energy-consuming processes.

The milk pasteurizer, which uses hot water from a geothermal heat exchanger, offers farmers a 7% cost reduction. GDC is already using the unit to pasteurize milk consumed internally. In the case of the grain dryer, thermal

energy from the hot geothermal fluids is transferred to fresh water which is then channeled to the grain dryer through heat exchange process.

The geothermal grain dryer operates at temperatures between 50°C and 60°C to dry grains and takes about Five (5) hours to dry six (6) tonnes of maize from 20 % to 14 % moisture content. The process cuts the cost of drying grains by 40 % compared to conventional fuel and electricity-based alternatives.

When geothermal fluid is used to heat fishponds, an increased yield is realized by reducing the maturity time from nine (9) months to six (6) months. Hence increasing output per year.

Greenhouse heating reduces growing time, increases quantity and quality of harvest, and reduces humidity in the greenhouses hence minimum uses of fungicides.

Eng. Martha Mburu has been at the forefront in the research and implementation and operation of Direct-Use projects at GDC Menengai. She has worked in the geothermal sector for more than 20 years. Her focus has been on Geothermal Direct-Uses.

"GDC is now focusing on commercialisation of the technology by partnering with investors. We've been marketing the use of geothermal heat for Direct-Use applications to investors to commercialize the project. GDC has already identified an area adjacent to the Menengai Geothermal Project where we plan to set up an industrial park. We have five (5) Direct Uses pilot projects which include geothermally heated greenhouses, fishpond, laundromat, milk pasteurizer and a semi-commercial grain dryer. All these projects are meant to showcase the Direct-use technology to potential investors," stated Eng. Martha Mburu.

According to Eng. Martha Mburu the success of the DU pilot projects presents a great opportunity for Kenya to tap into the geothermal energy and alternatively utilise the by-product of electricity generation to the benefits of major sectors such as food manufacturing and tourism as the energy utilisation efficiency is enhanced.

"Geothermal grain dryer for instance is a clean energy technology that utilizes geothermal fluid in the drying of grains. It is a cost friendly alternative and is not detrimental to the environment. The alternative is to utilise electricity to power the dryer or burn fossil fuel to boil water for drying, which poses great harm to our environment," said Eng. Mburu, adding that this was set to cut the cost of drying grains by up to seventy (70) percent.

Eng. Martha Mburu

> Geothermal grain dryer for instance is a clean energy technology that utilizes geothermal fluid in the drying of grains. It is a cost friendly alternative and is not detrimental to the environment.

Nakuru County is heavily endowed with the geothermal resource. This presents a perfect opportunity to set up an industrial park that will see geothermal resource supply the much-needed heat to support various industrial processes such as timber drying, milk pastuerisation, grain drying, hides and skin processing as well honey processing among others.

"We have generated informative data from our studies. An industrial park, powered by Direct-Use of geothermal energy is our next plan. We have done a detailed pre-feasibility study which have given us very good indication regarding the scaling-of these projects to commercial size," says Eng. Martha Mburu, the Manager, Direct Uses at GDC.

Indeed, this is one of the motivating factors behind GDC signing a Collaborative Framework Agreement (CFA) with the County Government of Nakuru, which aims to boost investment into the proposed industrial park in Menengai.

Eng. Martha Mburu is the Manager Direct Uses Department, Geothermal Development Company (GDC).

28TH IEK CONFERENCE

Engineers Accelerating
Sustainable Economic Recovery

By EiK Correspondent

THE Institution of Engineers of Kenya (IEK), in collaboration with the Engineers Board of Kenya (EBK), annually holds the International IEK Conference. The event, which brings together over 5,000 engineers worldwide, is the most anticipated event of the year among engineers. Last year, we held the 28th edition from 8th to 12th November, 2021 at the Pride Inn Paradise Beach Resort in Mombasa.

The theme, ***"Engineers Accelerating Sustainable Economic Recovery"***, was geared towards presenting an opportunity for delegates to reflect on the current and future challenges facing humanity, especially arising from the COVID-19 pandemic. Engineers and other scientists were called upon to generate impactful sustainable solutions to boost economic recovery.

The Conference explored issues around the fourth Industrial Revolution and industry, policy formulation, education, research, academia and development, Big 4 Agenda and Vision 2030, among others.

The conference started on Day 1 with the fourth Women Engineers Summit that took place on November 8, 2021. The main Conference started on November 9 with an address by the World Federation of Engineering Organisations' president, Eng Dr Gong Ke, EBK Chairman, Eng Erastus Mwongera, and IEK President, Eng Nathaniel Matalanga.

It was officially opened by President Uhuru Kenyatta, who was the chief guest and was represented in person by the Chief Administrative Secretary (CAS) in the Ministry of Transport and Infrastructure, Hon Chris Obure, EBS. In attendance was also Mr James Macharia, EGH, Cabinet Secretary for Transport, Infrastructure, Housing and Urban Development represented by his Principal Secretary, Dr Eng Joseph Njoroge, CBS.

Other notable guests included international delegates from the World Federation of Engineering Organisations and the Federation of African Engineering Organisations (FAEO) namely: Eng Martin Manuhwa, Ing Rev Prof Charles Anum Adams, FGhIE President, Ghana Institute of Engineers, Eng Abel Ngandu of Engineering Institution of Zambia, Ing (Mrs) Carlien Bou-Chedid, President of the Federation of African Engineering Organisations, Ing Dr Kwame Boakye, IPP Ghana Institute of Engineers, Eng Chanda Kelly Linus of Engineer Angolan Association (OEA), Eng Gentil Kangaho, president of the Institution of Engineers Rwanda and Eng Festus EM Martin.

Among the notable points in last year's event was the encouraging take up by sponsors and exhibitors. We had a total of 21 sponsors and 19 exhibitors. The main sponsor was the Kenya National Highways Authority (KeNHA), which took up the platinum sponsorship at Sh7 million. Other sponsors and exhibitors included Schneider Electric, Kenya Rural Roads Authority (KeRRA), Kenya Urban Roads Authority (KURA), Isuzu, KRB, NCA, Mabati Rolling Mills, Chattered Institute of Arbitrators, Watercup, Kenya Ports Authority, MegaPipes, to mention but a few.

The conference was covered extensively by the Kenya Broadcasting Corporation (KBC) throughout the entire period, with live coverage and interview sessions during the lunchtime news. We had a total of 60 papers presented, with 49 in the main conference and 11 in the Women Engineers Summit. A total of 26 countries were represented, including Australia and those from the Middle East, Europe and Asia.

The five-day event ended on a high note at the Gala Dinner with the Excellence Awards. Under the coastal night with the waves of the ocean softly crashing at the background, the curtains fell on the 28th IEK Conference. With over 1,500 engineers attending physically and over 2,000 joining in virtually, the Conference was a major success and we look forward to what the future holds.

Engineers follow the proceedings during the 28th IEK International Conference in Mombasa in November 2021.

4TH IEK WOMEN ENGINEERS SUMMIT

The 4th Women Engineers Summit, precursor of the 28th IEK Conference, was held on November 8, 2021. The Summit was graced by Ing (Mrs) Carlien Bou-Chedid, the President of the Federation of African Engineering Organisations (FAEO).

The theme of the summit was "Power of Diversity" and sought to address the glaring deficit in women representation in the profession and in other spheres of influence. The call was not only to bring women engineers together but to celebrate the difference that each brought to the table. The red themed event brought together 439 women engineers, with 250 attending physically and 189 joining in virtually.

It was hosted by the elegant Catherine Nyambala, who gracefully guided the discussions that centred on the diversity agenda, retention strategies, best practice in organisational interventions and policies that support inclusion and capacity Building. Empowerment for women engineers featured prominently in the conversations, with women engineers coming out strongly to support the expansion of opportunities in the engineering space for women. In recent years, many women engineers are emerging as successful trail blazers, a development conference speakers applauded as step in the right direction.

"While female engineers may still be the minority in the field, the growth (in numbers) is remarkable and there are many women who have become very successful in the industry. These women are breaking stereotypes and showing others that women engineers can succeed in the field, their gender notwithstanding," said EBK Registrar, Eng. Margaret Ogai.

Traditionally, participation of women in the profession has been marred by marital care responsibilities combined with busy schedules and demands of the career. The male-dominated STEM environment has also been cited as a contributing factor to the huge gender disparity in the profession.

"Women in Engineering face unique barriers. This summit seeks to support women engineers to pursue their innate capacity to be leaders within and without the field of engineering. Women engineers can equip themselves to gain a competitive edge in emerging landscapes," Ing Mrs Bou-Chedid told the attendees. Carol Koech, Country President East Africa Schneider Electric, Wanjiru Gathira, Senior Director at Conservation International, and Jane Amunga, the Diversity & Inclusion Expert at Safaricom PLC, made keynote addresses.

The day came to an end with an evening cocktail by the beach, where the ladies let loose and broke a sweat on the sandy dance floor.

A section of attendees during the conference.

Future-Proofing Organisations in the Digital Construction Era

By Pauline Wambui Maina, Patrick Waweru Gitee & Howard Humphreys

1. Introduction

THE first industrial revolution was marked by mechanization which was driven by water and steam power production. This was later following by mass power production, enabled by electric power production, ushering in the second industrial revolution. The third industrial revolution went further to enable automation through a fusion of electronics and information technology. Like previous industrial revolutions, the fourth industrial revolution has been an advancement of its precursor, thriving on a blend of technologies to give rise to the digital era. However, the speed of current innovations has no historical precedent (Rose, 2016) and carries along with it a need for rapid decision-making within organizations.

The conversation on digital transformation is on the rise in literally every industry and has slowly trickled into the construction industry which had, for a long remained mostly reliant on analog methods of documentation and delivery. The digital revolution presents a gold mine of data captured through various technologies which can be leveraged for actionable insights. However, this poses an unanticipated challenge. That of a deluge of data, in uncoordinated formats, and voluminous quantities which if not strategically managed can remain useless, if not expose an organization to numerous risks (Rose, 2016).

Accenture, a multinational cooperation that offers digital transformation and technology solutions, committed to the Digital Transformation Initiative alongside the World Economic Forum in 2015 to provide insights on the impact of digital technologies on businesses. Their digital transformation study in 2019 revealed that 78 percent of the 1350 senior industrial executives interviewed reported failed return on investment goals. Forbes Technical Council (2018) further states that 70 percent of initiatives to apply digital capabilities to transform businesses fail to meet their intended goals. This implies the need for a retrospective strategy in digital transformation, applying lessons learned by early entrants into the journey to enable leapfrogging.

> This study sets out to identify digital technologies within the construction industry, establish reasons why several past digital initiatives have failed, as well as identify means through which organizations can ensure that they succeed in the digital era.

2.Research Methodology and Findings

This study adopts a secondary research methodology, aimed at reviewing existing data on digital transformation within the construction industry. This methodology was selected in consideration of the limited time available for research and enabled the researchers to access a wide range of data as well as contributions from subject matter experts internationally. Initially, the study reviews data on the various digital capabilities currently being exploited in the industry with a focus on the role of reliable data for the success of these technologies. The study then reviews the shortfalls of digital integration into business processes with a view of establishing strategies that can be adopted by organizations to ensure lasting outcomes.

The last few years have seen the advent of numerous construction technologies. UK Connect identifies the crucial construction technology trends in 2021 to include Building Information Modelling (BIM), Virtual Reality (VR), Augmented Reality (AR), Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IoT), Robotics and drones, 3D Printing, Big Data, and Blockchain. This is in line with Gartner's (2018) findings, which further extend the list to include Digital Twins, Cloud and Edge computing, among other top strategic technology trends for 2019. These are only a few of the technologies currently in play, but perhaps currently the most impactful.

BIM is the intentional management of information through the whole life cycle of an infrastructure project. It entails considering the intended use for an asset at the beginning of the project and how it will be integrated, ran, and sustained. The BIM platform offers an avenue for the simulated construction of building components as well as coordination of all elements and processes before production (Maina, 2018). VR enables immersion into a computer-generated 3D simulated environment with a seemingly real interaction with this environment. AR on the other hand enhances elements in the real world by superimposing computer-generated graphics, thereby enhancing the real-world element. VR and AR coupled with BIM have limitless capabilities in enabling project collaboration, speedy decision making through improved visualization and understanding of project elements as well as potential safety improvements through construction simulation for process improvement.

AI is exhibited where computers or programs mimic human behavior. These machines are fed with a vast range of information related to the world to program them to respond with common sense as well as problem-solving and analytical capabilities. ML, a subset of AI, further introduces algorithms that assess past patterns to derive predictive insights (Marr, 2020). These concepts have been harnessed in the construction industry to embed environmental and geographical data on BIM Models creating digital twins which enable predictive design. These two concepts have further improved productivity in the industry by eliminating redundant processes and enabling automation. AI is especially useful in fast-tracking review of project management historical data to derive insights on cost and time management aspects (UK Connect).

Drone technology is currently being applied for site monitoring without the physical presence of construction professionals, as well as to deliver materials on site. In tandem with data captured by ground-based or Autonomous Mobile Robots (AMRs), drone data is relayed to VR technology, presenting a real-time view of site progress from any geographical location off the site. Additionally, robotics use in construction technology has enabled automation of some manual tasks such as bricklaying, delivery of materials using automated vehicles, as well as for demolition works. This reduces the time in which these tasks are performed significantly (Matthews, 2019). 3D printing, on the other hand, entails the use of printers fed with cement, molten metal, plastics, or other materials which solidify upon cooling or curing, which are linked to BIM software which feeds project element data to the printer enabling layering of the material to create a physical representation of the model. This accelerates product development by reducing the design to manufacturing cycle and is especially helpful in the manufacture of complex forms (Schwab, 2016).

IoT in the construction context entails technology-enabled systems which enable multiple elements, processes, smart devices, and sensors to create interactive and automated environments. This smart technology is used to boost efficiency and sustainability by the use of sensors to switch off systems and machines during idle time, as well as automate redundant processes and enhance safety on sites through alerts. The concept of Digital Twins, a virtual asset coined from a physical asset, has been progressed to blend IoT, AI, ML, and BIM. This results in a digital model which can be manipulated and optimized for efficiency, predict outcomes based on scenario analysis, and ultimately derive maximum value for clients (Monteith, 2019).

Big data refers to extremely large data sets from internet searches, social media, and other digital communication media, which create a digital footprint that can be analyzed to uncover hidden trends and correlations between elements. Energy, weather, traffic, and geolocation data are linked to BIM systems to determine ecological impact as well as optimize sustainability solutions, in addition to scheduling project management and facility maintenance activities (Marr, 2016). Cloud computing technology allows for access, use, and manipulation of data stored in remote servers relaying data to construction participants in real-time. This facilitates efficient collaboration. Similarly, edge computing facilitates the processing of data on smart devices such as phones and tablets at the source.

The sheer number of parallel innovative construction technologies can be overwhelming (Oswald, 2017). Ironically, Forbes, the World Economic Forum, Accenture, among other institutions that have invested in research on the performance of digital interventions conclude that 70-80 percent of digital innovation strategies fail. McKinsey's Digital Global Survey 2016 and 2017 suggests that this is the case because a majority of incumbent business models fail to acknowledge that digital innovations disrupt the traditional nature of competition as illustrated in the figure below.

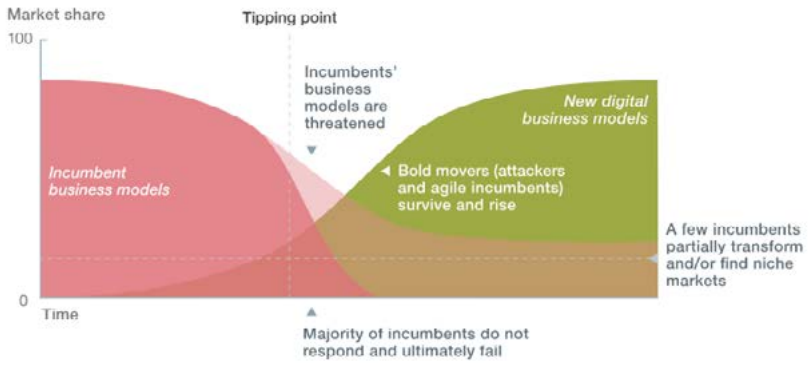

Figure 1: *Influence of digital disruption on Market Share/ Competition*

Oswald et al (2017) argue that these technologies present complexities due to vast connectivity. This creates the need for agility, and smart decision making to increase efficiency and respond in real-time to ever-changing customer demands in addition to posing a digital information security challenge. Failure to acknowledge that digitization disrupts the traditional operation and strategic models results in organizations approaching digital transformation in isolation, as opposed to reviewing its effects on every aspect of the business. Moreover, these efforts to reinvent the business need to be done iteratively, given the rapid rate at which technology is changing.

This failure is also linked to uncoordinated digital efforts without a systematic approach or within silos, and without the commitment of the entire organization. Additionally, Schwab (2016) submits that the requisite institutional framework governance for innovation is inadequate, if not absent altogether. The lack of a clear direction on digitization objectives, allocation of resources, and responsibilities results in a vicious cycle with no way to measure the impacts of implementation. Without this framework, digital interventions are applied in isolation with no focus on the long-term objective which makes them ultimately unsustainable.

Failure to understand that digital strategies will vary from company to company is yet another challenge. McKinsey proposes that to survive in the digital economy, two broad principle categories apply to organizations. There are digital reinventors who are first movers who make heavy technological investments and major changes to their business models. However, not all companies can afford this venture. The second category of organizations is fast movers who are highly adaptive to digital changes, learning from mistakes of the digital reinventors and refining innovations as opposed to reinventing the wheel.

Accenture categorizes these challenges into six broad deficits. Alignment deficit refers to a lack of harmony across the organization on digital value as well as the approaches to adopt to harness its capabilities. Infrastructure deficit denotes to shortage of technology to enable innovation within an organization. Skills deficit, on the other hand, implies the insufficiency of skills to create value on digital platforms. Partnership deficit is listed as yet another challenge, pointing towards limited collaboration with strategic partners who can jointly leverage technology and innovation. Further, Accenture defines measurement deficit as failure to define metrics against which any innovation can be compared to determine implementation success. Finally, the lack of a digital culture which is a prerequisite for the growth of digital initiatives is defined as Cultural deficit. These deficits when combined, are among the leading causes of digital implementation failure.

Digital innovation must be tailor-made to suit an organization's context and should be evaluated carefully for sustainable implementation. There's no question as to whether taking up the digital transformation journey is worthwhile. If anything, institutions that are left out of this sprint are likely to become redundant. These initiatives however carry along significant financial implications; thus it is necessary to rethink tactics to surmount the implementation challenges identified.

3 Discussion

Investing blindly in technology can be a wild goose chase, as technology is rapidly changing with the daily advent of innovative solutions. Niessing et al (2020) recommend that businesses need to adopt a digital resilience strategy, anchored on leveraging data and technology to drive customer value. This is the only way organizations can survive in the long-term. The digital revolution orbits around data. Any software or technology is only as good as the data fed into it, which calls for the need for a structured approach to data collection, manipulation, relay, and archiving. An organization's efficiency greatly depends on its ability to manipulate and synthesize data pertinent to its processes for its benefit. The information generated through construction process keeps escalating, with multiple stakeholders feeding into the process as well as with the increasing complexity of construction projects (Maina, 2018).

Rogers (2016) alludes to the fact that digital transformation is not about technology, but is instead about strategy, listing five key domains for consideration: customers, competition, data, innovation, and value. Oswald et al (2017) further add people and skills, business models and processes as well as organizational culture to the key dimensions critical for successful digitalization. Businesses and industries are called upon to reinvent themselves, and more importantly, to adopt an agile strategy, as the shift from analog methods carries along with it a need for versatility. Customers' pain points should be at the core of business digital strategies and models. With greater access to information, clients form the best focus group to engage in developing dynamic solutions that derive optimum value.

Digitization disrupts the traditional concept of competition, with new entrants into markets typically controlled by core service providers. Mobile technology firms, for example, are slowly bringing value into the construction industry which was predominantly served by construction professionals. Organizations, therefore, need to consider strategic relationships where they focus on what matters and leave the rest to the experts in the field, a concept known as digital out-tasking, thereby leveraging on competition (Oswald et al,2017).

Data is the lifeline of every organization. With digitization, data is generated in large volumes, in structured and unstructured formats, which has proved to be valuable in developing insights on customer feedback and product performance (Chaki, 2015). Big data is, however, often not valuable in its native format unless synthesized to add value. The need for the evolution of workforce skillsets is eminent, with the emergence of tech roles and competencies for data collection and coordination for downstream analytics to ensure that the right data is acquired and amalgamated to generate value. Additionally, business intelligence experts are required to derive actionable insights from the data by asking the right questions, creating test scenarios for analysis, and enabling data visualization. Data

scientist's role in creating algorithms that are used to predict outcomes which can then be used to progress recommendations has also proved to be critical in the digital scene (Niessing, 2020).

Developing technical solutions off these analytics may imply heavy technological investment. However, unlike traditionally where the focus was on producing a final product before releasing it into the market, the current trend advocates for the release of minimum viable products which allow for incorporation of customer feedback and variations to accommodate rapidly changing needs and technology. This has been found to save time and reduce costs while improving on the product and organizational learning (Rogers, 2016).

Organizations can also invest in strategic relationships for collaborative innovation where firms that lack specific skills such as customer analytics but have capital and mature operations can collaborate with counterparts with the latter, or vice versa. This combined approach to a company's digital strategy turns data into an asset for long-term value, keeping abreast with customer needs and the changing environment to uncover unexpected patterns and unlock new sources of value. Ultimately, integrating any change into an organization has its challenges, thus this journey is not expected to be without its pitfalls. Leaders must therefore ensure that a digital culture is cultivated by actively engaging their teams in the implementation process. This aids in creating a sense of individual ownership of the journey as well as a commitment to the company's overall strategy.

4 Conclusions

To harness digital prospects, organizations must go beyond simply leveraging emerging technologies. The digital economy calls for a new setup with improved technical capabilities. The need to reinvent business models around customer needs, investing in a workforce with the right skills as well as upskilling of the current workforce, in addition to the development of collaborative partnerships based on mutual trust is eminent. Moreover, businesses are required to adopt a data-driven approach where business intelligence is derived from effectively synthesized data. Ultimately, this will result in extended intelligence with agile business decision support systems.

More important than acquiring core technology is digitizing the mindset of decision-makers. Businesses should ensure that they begin with an audit on their readiness for digital transformation which aids in the identification of technology and resource gaps as well as a clear road map from the current state to the desired state. Over and above being ready to identify their strategic blind spots, it is imperative for organizations to rapidly implement the necessary changes, and to commit to an iterative journey of learning and unlearning to survive in this digital space.

The writers work at Howard Humphreys ConsultingEngineers, Nairobi, Kenya. Email: wambuikanyua@gmail.com

INSTITUTION OF ENGINEERS OF KENYA - EXCELLENCE AWARDS

S/NO	WOMEN AWARDS	
1	Outstanding Female Mentor Award	Eng. Joan Anyika Otike PE, MIEK
2	Advocating for Women in Engineering Award	Keziah Wanja Ntwiga
3	Young Woman Engineer Award	Diana Adhiambo Macodawa
4	Emerging Leader Award	Anne Wacera Wambugu
5	Distinguished Engineering Educator	Prof. Eng. Benedette N. Waswa Sabuni, PE, MIEK

S/NO	INDIVIDUAL AWARDS	
1	Education Award	Prof. Eng. Francis John Gichaga, CE, FIEK
2	Graduate Engineer Award	Jama Abdi Fatah
3	Young Professional Engineer of the Year	Eng. Esther Khatenje Segero, PE, MIEK
4	Professional Engineer of the year Award	Eng. Kahoro Wachira, PE, MIEK
5	Consultant Engineer of the year Award	Eng. James Njoroge Mwangi, CE, FIEK
6	Distinguished in Mentoring Graduate Engineers	Eng. Ezekiel Fukwo Wafula, PE, MIEK
7	Individual - Leadership in Engineering	Eng. Peter Mundinia Mbuthia, PE, MIEK

S/NO	CORPORATE AWARDS	
1	Corporate- Public Organization	Kenya National Highways Authority (KeNHA)
2	Corporate- Private Organization	Schneider Electric

Spatial Planning & Development Control – the Missing Link in Sustainable Infrastructure Development

By Eng. Howard Ashihundu M'mayi

1 Introduction

SPATIAL planning and development control in Kenya is governed by The Physical and Land use planning Act of 2019 which replaced the repealed Physical Planning Act 1996. The Act sets out forums and committees to implement functions of planning and control. It also spells out steps for developing spatial and land use plans. It further outlines the considerations for land use control including zoning, land subdivision and amalgamation, site planning and building erection, integration with abutting infrastructure, building lines, easements, set-backs as well as designating green public spaces.

The Ministry of lands, in aligning with the law, developed The National Spatial Plan 2015-2045. The ministry further developed the County Spatial planning guidelines in 2018. These guidelines were meant to set up administrative structures at the county level to operationalize Physical and land use planning as envisaged under the 2019 Act within the context of devolved governments.

The roads Act No. 2 of 2007 revised in 2012 on the other hand provided the framework of implementing the Roads infrastructure agenda. It set up Roads agencies, outlined their roles, powers and responsibilities. It also developed a road classification for national and county roads in line with the Constitution of Kenya.

The Road classification is aligned with the National and county spatial plans to achieve the key objectives of health, safety, amenity efficiency, aesthetics and conveniences of the community generally and to the proper planning and density of development and land-use in the area as outlined in the third schedule, cl 2 of the physical and land use planning Act 2019. National Roads are classified as S, A, B and C where class S, A&B are under the management of The Kenya National Highways Authority. All the highways under this category are meant to provide mobility, safety and travel comfort as a matter of priority.

However, Kenyan Roads infrastructure has been choking under uncontrolled development. This has been characterized by urban sprawl, heavy encroachment, indiscriminate direct access to highways, heavy presence of pedestrians on the highways and at the worst, marketplace activities on highways. This has caused diminished efficiency of the amenity, increase accidents in frequency and severity, high cost of new projects due to compensation, relocation of services and claims arising from lost construction times.

2 Approach

Considering the existing disparity between the ideal planned spaces and the real situation across the country; the author sampled road sections running through urban and rural areas on National Highways within Coast region to highlight the gaps, examining their causes and the effects and proposing solutions.

The study also collected data on development projects within Mombasa on the costs of uncontrolled development arising from land acquisition, compensation, project delays and the ensuing contractual claims.

3 Results and observations

3.1 Typical sections of the roads through urban built-up areas

The worst affected sections of the National Highways network as a result of poor controls in spatial plans and development is the urban centers. The phenomenon of urban sprawl has adversely affected the roads infrastructure by the number of buildings both formal and informal. Rules on setback, easements and building lines have been breached extensively, consuming road reserves and spilling pedestrian activities onto highways.

Below are aerial and street view images of locations within townships illustrating the level of encroachment and breach to spatial planning.

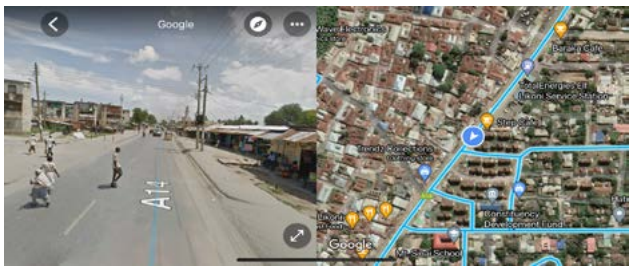

Fig. 1. Street view and aerial view of Road A7 in Likoni township showing contrast of a planned and unplanned coexisting developments

3.2 Typical sections of the roads through rural areas

Rural areas have not been spared from breach of spatial planning and development control. Physical plans

developed by the planners have often times been distorted by unchecked land subdivision, developments that don't match the land-use plans, issuance of multiple direct access to the highways and ultimate additional generation of pedestrian traffic on the roads. Mushrooming of social amenities like schools and places of worship has also led to increased application for speed calming measures lowering the efficiency of the road infrastructure. The piecemeal measures have proved costly, ineffective and unsustainable

Below are aerial and street view images of selected locations in the rural areas illustrating breach of development controls;

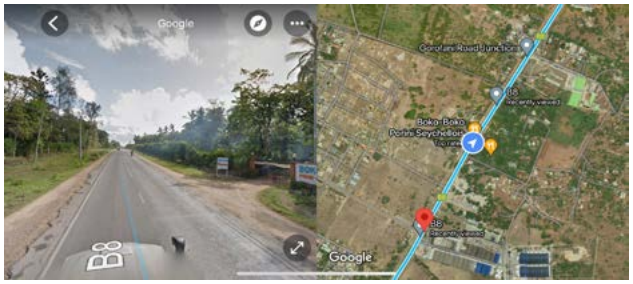

Fig. 2. A street and aerial view of Road A7 in Kikambala, Kilifi County. Note the risk of sprawl, random mix of land-use and direct access from individual property.

3.3 Consequent cost of Spatial planning & Development control along National Highways in Mombasa County

A sample of ongoing and recently completed projects within Mombasa was identified and the costs of the project examined. This was to quantify the cost of construction contrasted with the cost of acquiring the corridors and further related costs. It was noted that failure to control development within the highway's development corridors has led to high costs of acquisition which also comes with stakeholder management challenges at times leading to protracted litigations.

Unavailability of ready cash for compensation was also noted as a cause for further project delays attracting extension of time claims with related costs.

Below is a breakdown of project costs on the selected 4 no projects

Table 1. Project financial impact from ineffective spatial planning and development control

Description	Road 1	Road 2
Cost of Civil works (Kshs)	2,797,802,578.00	2,420,327,530.00
Cost of land acquisition (Kshs)	2,703,399,675.00	2,697,004,754.00
Claims by Contractor (Kshs)	1,320,100,000.00	2,139,170,635.50
Awarded claim (Kshs)	727,457,070.00	TBD
Project extended time (Days)	448	476
Remarks	Project closed	Ongoing

Description	Road 3	Road 4
Cost of Civil works (Kshs)	8,538,736,259.00	11,545,904,880.84
Cost of land acquisition (Kshs)	2,700,000,000.00	1,353,180,000.00
Claims by Contractor (Kshs)	3,366,840,491.71	Nil
Awarded claim (Kshs)	TBD	Nil
Project extended time (Days)	822	Nil
Remarks	Project ongoing	Project closed

4 Discussion

Sustainable Highway development is characterized by roads that provide mobility, safety, ride comfort at a cost that gives higher value for money. This is achievable only when there exist proper land use plans providing fairly predictable highway design parameters for the longest projected timelines. The spatial plans MUST be followed through dedicated and consistent development control. There's however a long way to go in correcting what has gone wrong, restoring a culture of order and sustaining it going forward.

The guiding laws have been enacted, the guidelines ratified and a framework created both at National level and county levels. It was however noted that there's no IEK nominee to the National and County Consultative forum and the inter-county joint planning committee which are organs established by the Act. Further, the liaison committees at National and county level have left out Engineers representatives and the Roads agencies who are critical to the role of development control. This has led to disjointed working, occasioning lapses we see today and shall require amendments to the Act.

Counties have not developed comprehensive spatial and land use plans. Some have the plans but with serious deficiencies for instance; they're not georeferenced thus not useful for control. And those with actionable plans have not yet put together a clear strategy to correct the existing mess and restore a culture of order for political reasons. Consequently, we have continued seeing new developments coming up randomly with drastic difference in the architectural character and purpose (industrial, commercial, residential, social, etc). It may be necessary to develop a marshal plan and strategy for implementation of development plans with proper monitoring and tracking.

Erection of buildings has continued without regard to the rules of plot coverage, infrastructure adequacy, set-back, building line restrictions, appearance and other requirements in the third schedule of the P&LUP Act 2019. This has led to choking of highway infrastructure

reducing the efficiency, lowering the level of service and making road usage highly unsafe both for vehicles and pedestrians. High frequency and severity of accidents is observed where many buildings, formal and informal, commercial and residential are erected opening up into the road corridor. This happens because of increased number of pedestrian activities within mobility ways.

The type of buildings (permanent or temporary, high-rise or low rise) determines the cost of future compensation during expansion. If the type of buildings of first row of land to highways can be regulated; runaway cost of compensation can be contained. This requires legislation at national level and county level.

Physical speed controls have been used in an attempt to improve road safety and reduce fatalities & severe injuries. This solution has proven not to be appropriate. In some instances, it has increased the severity of accidents and in general it has led to faster deterioration of road infrastructure by damaging the pavement (by extra loading due to vehicle braking) leading to higher unsustainable maintenance costs. Development plans must incorporate concerns from infrastructure agencies. Direct access to highways must be restricted at all cost, and all buildings erected along highways MUST face away from the highway and open into spur roads or service roads with clear designated exit and entry points into highways and proper pedestrian crossings.

Road classification as per the Kenya roads Act is intended to help planners develop appropriate and sustainable land-use. Highways MUST definitely be treated differently from city streets, estate roads and rural access roads. Mobility, safety and comfort is the guiding principles in spatial and land use planning along highways and all developments must be checked on how they promote the three or else be prohibited altogether.

5 Conclusions

Spatial & land use planning and development control has existing gaps which if closed will drastically revolutionise infrastructure development putting it on a firm path to sustainability. It will work well when government takes lead.

Enhancement of legislation to make them inclusive of lead infrastructure professionals; rollout of a national drive by top leadership; recognition of road classes; completion of actionable development plans; dedicated enforcement and operationalization of forums/committees established by law are seen as key steps to leverage on what we have (monetary & natural resources, land and laws) for posterity.

The writer works at Civil Engineering & Construction Law, Nairobi. Email: howard.mmayi@gmail.com

ENGINEERING EXCELLENCE AWARDED

Kenya National Highways Authority (KenHA) Engineers collect an Award during IEK's Engineering Excellence Awards in November, 2021.

Eng. Dorine Kirima (right) awards a winner at the Engineering Excellence Awards in November, 2021

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BUILDING TRUST

"Great brands are not built overnight", **The most successful brands know that this is a myth that only works in fairy tales. The truth is that the best companies take time to build – any successful company requires a strong base on which to grow and develop**.

Sika Kenya Limited, a subsidiary of Sika Group, was established in 2011 and the company has grown over the years and made a mark for itself in Kenyan and East African construction market. Nowadays, the company has become the leading manufacturer and distributor of construction chemicals in the country and has the biggest market share across the region.

Sika's Target Markets are connected with various aspects in the construction industry. They involve: Concrete, Waterproofing, Roofing, Flooring, Sealing & Bonding, Engineered Refurbishment, Building Finishing, and Industry.

Majority of Sika products are locally manufactured although some products are imported from sister companies in Africa, Europe, Middle East, and Asia. Sika Kenya has a chain of distributors who sell Sika products and supply big projects directly as well.

Since 2011, the company has seen a tremendous growth which has led to supplying new markets. Sika Kenya is not only supplying the market in Kenya, but also in Uganda, Rwanda, South Sudan, eastern part of DRC, Burundi and partly Somalia. Each market comes with its own challenges and their aim is to ensure that Sika Kenya overcome all challenges that customers might face and provide best products and system solutions backed by strong technical support on site.

MECHANICAL AND TRANSPORT DIVISION

SEAMLESS CONNECTIVITY

MINISTRY OF TRANSPORT, INFRASTRUCTURE, HOUSING AND URBAN DEVELOPMENT

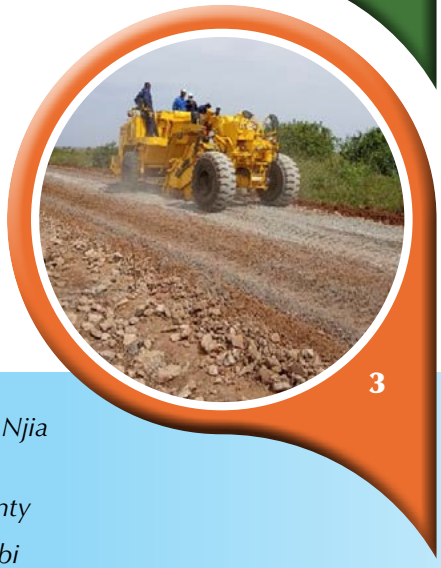
Eng. Maurice S. Nabende
Ag. Chief Engineer (Mechanical)
State Department for Infrastructure
Mechanical & Transport Division

Mechanical and Transport Division (MTD) is a Division in the State department of Infrastructure in the Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works. The Division plays a pivotal role as the Principal adviser to the Government on all matters relating to mechanical, transport and plant services.

The Vision of the Division is: *To become a world class provider of mechanical, transport and plant services.*

The Division has the following Mission: *To provide quality mechanical, transport and plant services to enhance development and maintenance of roads and other related infrastructure in Kenya.*

MTD is the implementing agency for the Mechanical and Transport Fund (MTF) which is a revolving fund whose basic function is to provide an efficient and effective funding system for mechanical and transport services which serve to support and develop infrastructure in the country. The Mechanical and Transport Fund (MTF) was established in 2003 through Legal Notice No. 140 under Exchequer and Audit Act (CAP 412).



1. *Road Opening in Meru County, Njia Ward*
2. *Grading Works: Kakamega County*
3. *Soil stabilization works at Nairobi National Park*
4. *Excavation and Loading: Vihiga County*

Provision of vehicles, plant and equipment to clients on hire basis. These equipment are used for opening of new roads, grading, gravelling works, Construction of water Pans and Dams, Excavation of trenches for water systems, Constructions of airstrips and buildings, Clearance of bushes and excavations for building foundations;

Manufacture of safes, cash boxes and spare parts, Manufacture and repair of Furniture and Upholstery, Panel beating and Spray painting, Foundry and sheet metal works;

Development and providing technical specifications, Evaluation of tenders for procurement and lease of vehicle, plant and equipment;

Provision of Government transport services;

Driver testing, Transport assessment, Valuations of vehicles, plant and equipment;

Inspections of vehicles, plant and equipment for conformance to technical specifications;

Inspections for repairs, inspections in view of disposal, inspections and approval of private garages for repair of government vehicles, Inspection of fire fighting vehicles;

Testing of speed governors, Inspection of truck tag-axle Conversion;

Certification of new models being introduced in the market.

The Division has a large fleet of equipment totalling 600 units among which are Bulldozers, Excavators, Motor graders, Wheel loaders, Dump Trucks, Soil Stabilizers, Rollers, Water bowsers, Chip spreaders, Bitumen Distributors, Prime movers, Mobile workshops and supervisory vehicles. Road working equipment are hired to both public and private sectors using gazetted rates.

MTD is headquartered in Nairobi, Industrial Area, Machakos Road and is headed by the Chief Engineer (Mechanical). The Division's activities cover all counties through 27 strategic regions administered at Regional and county centres countrywide.

The Division has a large pool of technical staff among who are Mechanical Engineers, Technicians, artisans and support staff.

Since the advent of devolution, County Governments, have benefitted greatly from partnership with MTF in their infrastructural developments by obtaining value for their money through delivery of quality roads from MTF services. The following counties have engaged the services of MTF in delivery of quality roads to citizenry: Kisii, Nyamira, Bungoma, Kakamega, Nyeri, Kitui, West Pokot, Baringo, Nyandarua, Machakos, Kiambu and Meru. In addition, MTF has supported thousands of contractors through provision of the road working equipment.

The strategic direction of the Division is to become a Semi-Autonomous Government Agency so as to enhance its service provision.

CONTACT US

Any enquiries on services available should be made at the earliest opportunity to: Chief Engineer (Mechnaical)

Machakos Road, Industrial area, P.O Box 30043-00100 Nairobi.

E-mail: cmte@mechanical.go.ke / info@mechnaical.go.ke

Sustainable Construction of Steel Reinforced Concrete Structures by Design for Durability

By Gladwell Wanjiku Nganga, Siphila Wanjiku Mumeny and Silvester Ochieng Abuodha

1 Introduction

KENYA is a rapidly developing country with a growing urban population. To facilitate this growth, the government has developed strategies such as Vision 2030 and the Big 4 agenda. Engineers play a key role as enablers in ensuring that these strategies are achieved and that the construction of these much needed infrastructure is attained. For example, for the development of transport infrastructure, there have been several projects such as the Nairobi Expressway project, LAPSSET, the Standard Gauge Railway, to mention but a few. For these projects, there is a wide use of steel Reinforced Concrete (henceforth, RC) for structures such as culverts, bridges and port's infrastructure.

This paper provides an overview on deterioration of concrete structures with a focus on corrosion of steel in RC structures, considerations made in design for durability of these structures, and a proposal on how this approach can be adopted in Kenya.

2 Deterioration of concrete structures

Durability is defined in ISO 13823 (2008) as the capability of a structure to satisfy, with planned maintenance, the design performance requirements over a specified period of time under the influence of environmental actions. Two key aspects to ensuring durability of a structure is understanding the deterioration mechanism that occurs in a particular environment, and ensuring adequate maintenance during the service life of a structure. For deterioration to occur in a given environment, there is ingress of aggressive agents by penetration where the transport mechanisms can be by permeation, sorptivity, diffusion and migration.

Alexander et al. (2017) categorize the deterioration of concrete structures to be either:

i) Physical deterioration e.g. abrasion and wear, thermal effects, and,

ii) Chemical deterioration e.g. leaching and efflorescence, alkali aggregate reaction, sulphate attack, corrosion.

Of the abovementioned, corrosion is the most pervasive deterioration mechanism in steel RC structures. A concise overview of this is provided below.

2.1 Corrosion of steel in steel RC structures

Corrosion is an electrochemical reaction that occurs on the surface of embedded steel reinforcement (Bentur et al. 1997). For corrosion to occur, the relative humidity should be in the range of 70 - 80% which influences moisture level in concrete pores. The steel reinforcement is in a passive state when the pore solution has a high alkalinity (ranging 12.6 - 13). This alkalinity is reduced when carbonation occurs or with ingress of chloride ions into the concrete cover.

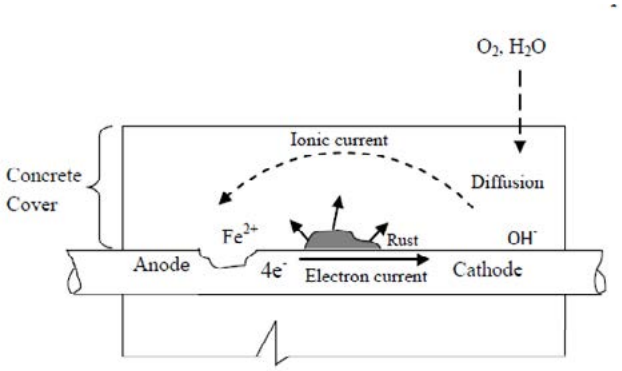


Figure 1: *Schematic illustrating the corrosion of steel in RC structures*

The properties of the concrete cover, its penetrability and depth, provide protection to steel reinforcement. In design and construction, these properties need to be carefully considered and verified in a structure, as they have a considerable impact on durability of a concrete structure (Alexander et al. 2017, Torrent 2019).

3 Design for durability

3.1 Prescriptive approach

The current approach used in design for durability, as provided in the Standard Specifications for Roads and Bridge construction (1986) is described as prescriptive with provisions of a maximum water/cement ratio and minimum cement content depending on exposure conditions (moderate, intermediate and severe). The limitations of this approach are:

i. Exposure conditions provided can be subjective and there is need of a more rigorous description e.g. as given in EN 206-1 (2013);

ii. Parameters given are difficult to verify on as-built structures e.g. measuring the cement content to determine compliance with the minimum provided in the specifications;

iii. Quality control measure of determining the compressive strength which is not directly related to durability;

iv. This approach limits flexibility and innovativeness in choice of materials that can be used in a structure;

v. The construction effects of compaction and curing are not considered in this approach.

Due to these limitations, there has been a shift globally (mainly in Europe, North America and South Africa) in the design approach for steel RC structures from a prescriptive to a performance-based approach (Alexander et al. 2017).

3.2 Performance-based approach

This approach involves determining the dominant deterioration mechanism in a given environment with the use of mathematical models. This models consider the rate of transport of aggressive substances that cause deterioration (Alexander et al. 2017). For a given service life and cover depth, which depends on use of the structure (BS EN 1992 1-1, 2004), the service life models are used to obtain a measurable parameter relating to material quality.

ISO 16204 (2012) outlines two strategies of service life design to resist deterioration:

i. Full probabilistic approach, partial factor method and deemed to satisfy;

ii. Avoidance of deterioration method.

From the above mentioned service life design methods, limit values of material properties (e.g. diffusion coefficient) which can be verified during construction are obtained. These measurable parameters form the basis of performance specifications which need to be clear, measurable, achievable and enforceable (Lobo et al. 2005).

3.3 Challenges in implementing the performance-based approach

The introduction of a new approach in the design for durability of steel RC is expected to have its challenges. This include:

i. A reluctance to change the design approach due to a conservative nature in the construction industry and lack of to fully understanding deterioration mechanisms in steel RC structures and its impacts (Alexander et al. 2017);

ii. There is no universal performance test method, and the developed tests do not adequately consider the construction effects on properties of the concrete cover of a steel RC structure (Alexander and Beushausen, 2019);

iii. Most of the tests recently developed, are short-term in nature and there are no correlations as yet between these tests and long-term performance (Alexander et al. 2017);

iv. The tests developed mostly consider one deterioration mechanism but in the as-built structure, there may be more than one deterioration process occurring at the same time (Beushausen et al. 2021).

4 Proposals for adopting design for durability in Kenya

There is a need in Kenya to ensure sustainable construction of steel RC structures by designing and constructing durable structures (Koteng, 2013, Otieno, 2019). To enable design for durability of these structures, the following aspects could considered:

i. Provide a more rigorous approach in defining environmental conditions e.g. as given in EN 206-1 (2013), adapted to Kenyan conditions;

ii. Selection of a suitable service life design model which is based on the dominant deterioration mechanism in a given environment;

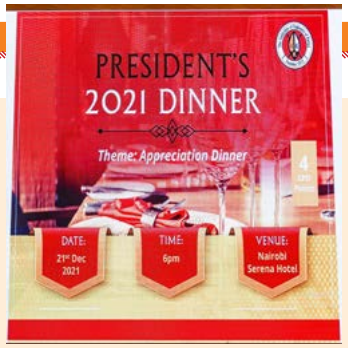
iii. Adopting performance tests which have been developed in other jurisdictions;

iv. Development of performance-based specifications that will be an additional quality control measure for RC structures with regard to durability.

5 Closure

This paper provides a brief overview on deterioration of steel RC structures and design for durability. The lack of durability results in costly repairs and rehabilitation measures. There is a need to shift from the current prescriptive approach, which has several limitations, to a performance-based approach. This latter approach has the benefit of determining the properties of the concrete cover of steel RC structures which strongly influences durability – its penetrability and depth. There are challenges with the use of a performance-based approach, the main one being lack of a universal test. Torrent (2019) argues that if we are to wait for a perfect durability test, we might never leave the unsatisfactory and ineffective current prescriptive approach. The consideration of design for durability of steel RC structures, in addition to strength, will enable Kenya to achieve efficient use of its financial and material resources.

Gladwell Wanjiku Nganga, Siphila Wanjiku Mumeny and Silvester Ochieng Abuodha (University of Nairobi, Civil and Construction Engineering), and Thomas Ochuku Mbuya (University of Nairobi, Mechanical and Manufacturing Engineering)



Improve schemes of service for engineers, IEK urges State

By EiK Correspondent

THE Institution of Engineers of Kenya (IEK) has called upon the government to come up with policies to improve the schemes of service and create more job opportunities for engineers.

IEK President, Eng Nathaniel Matalanga, said the institution has been pushing for the development and review of a schemes of service that allows for flexibility in changes of salaries and allowances for IEK members in the civil service.

> We need to have regular review of these policies and ensure that changes which are introduced in the grading structures through government documents are simultaneously incorporated in the respective Schemes of Service.

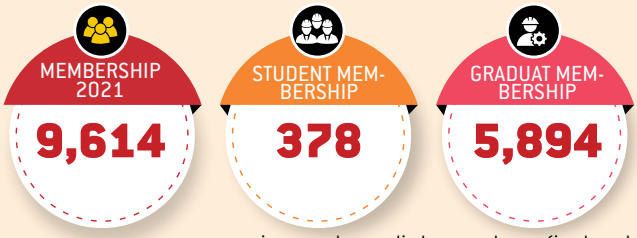
said Eng Matalanga.

He was speaking during the 2021 IEK President's Dinner on December 21, 2021 in Nairobi.

The president said just like doctors and other professionals in the civil service, engineers in public service deserve a non-practising allowance (NPA) as a trade-off for making an extra income by not engaging in private work.

"We need these officials to concentrate on serving the public without distraction. Unfortunately, we currently do not have any policies to this effect," he said.

Eng Matalanga regretted the paradox that graduate engineers are still unable to secure jobs, despite a shortage of engineers in Kenya. He said although at least 2,000 engineers graduate every year, there are only a little over 2,500 certified engineers against a demand of 20,000.



"I would like to call upon the government and stakeholders to prioritise investment in manufacturing, research, road construction and other experiential sectors where our graduates can get absorbed immediately after graduation. We need to restore the faith of foreign investors in the training of local graduates so as to increase their employability chances," he said.

The president also waded into the long debate of local professionals and firms not being engaged in the government's large infrastructure projects.

He said the involvement of local engineers in these projects can make a major contribution to the country's economy by providing jobs, cutting down project costs and advancement of skills and technology.

"This can easily be achieved by making changes to the government and investor procurement policies because as things currently stand, the procurement of infrastructure projects does little to benefit local consultants, contractors, suppliers and manufacturers in the country," he said.

"We applaud the recent move by the government to localise the operations and management of the SGR," he added.

Eng Matalanga encouraged fellow engineers to have more presence in the counties to take advantage of devolution and the benefits that come with it. He urged IEK branches to start getting involved in the county assemblies this year, and in the development of the County Fiscal Strategy Paper, the County Annual Development Plan, we should give input to the County Finance Bills.

The echoes were buttressed by Kenya National Highways Authority (KeNHA) Board of Directors Chairman, Eng Wangai Ndirangu, who said devolution has provided opportunities for engineers to deliver essential services at the counties such as water, health, environmental conversation and food production.

IEK President, Eng Nathaniel Matalanga, hands the Excellence Award to Eng James Mwangi of Kurrent Technologies.

"To blame the counties for lack of engineering professionalism is to admit collective failure to addressing the capacity needs of important institutions of public administration. Engineers need to work at the counties and the counties requires adequate number of qualified engineers," said Eng Ndirangu during the Dinner.

Eng Matalanga urged more graduate engineers to join the IEK and practice as recognized professionals. He said there has been a 48.07 per cent growth in membership as the Institution works towards achieving the goals set in the 2019/2023 strategic plan of growing the IEK membership to 20,000 by 2023.

The current membership of IEK stands at 9,614, with student membership at 378 and graduate membership at 5,894. In 2021 alone, 157 members upgraded to Corporate Class, said the president.

IEK's Eng Grace Kagondu, KPLC CEO Eng Rosemary Oduor, Eng Matalanga and IEK's Eng Christine Ogut.

IEK 2nd VP Eng Eric Ohaga, Council member Eng Doreen Kirima, 1st VP Eng Lucy Mutinda and Eng Howard M'mayi.

Attendees during the president's dinner.

Meet the elegant Eng. Catherine Nyambala:

The buoyant lively Engineer MC who brings life and laughter to IEK events

SHE has won several awards including the Goldman Sachs and Fortune Global Leaders Award and The Top 40 under 40 Women's Award. In 2021, she was Chief Judge of the Kenya Association of Management, Energy Management Award. You will find her spreading cheer and laughter at IEK events as Master of Ceremonies (MC), a job she does with passion and relish.

This past year, she has lit up the stage in many high-ranking events as MC, including at the IEK Excellence in Engineering Award Ceremony that turned out to be a great night full of pomp and colour. She does it so well one would not know she only does it for a passion.

"I was honoured to be the Master of Ceremony in the first IEK Excellence in Engineering Awards as well as the Women Engineers Summit. No, I am not a professional MC, I am an Electrical Engineer currently engaged in the Energy sector. And no, I did not just appear from nowhere to MC the event I was part of the process from the outset. I have extensive experience with Awards and events, having been involved in many," the elegant Eng. Nyambala told Engineering in Kenya Magazine.

She also revealed the tedious intrigues involved in finding deserving winners of award ceremonies. "It took a wide range of Engineers working under the leadership of the Second Vice President to make the Awards happen. A concept was developed and presented to the Council, once approved a detailed criteria was developed. After approval of the criteria, a form for data collection was designed and the Awards communicated to members for response," says the KenGen PLC Engineer where she is Manager in charge of *Business Process Improvement.*

A technical Committee made up of seasoned professionals sieved through the nominees and recommended outstanding Engineers to a panel of Judges who adjudicated the final awardees. "Emceeing the event was thus just the icing on the cake: Engineers had to be kept engaged, time had to be managed, the correct names had to be called out to present the awards and most importantly the correct names had to be called out to receive the awards," she says.

First was the Women Engineers Chapter Awards. This was followed by the individual Engineers Awards and then the Corporate Awards. The most distinguished Award of the night; the Excellence in Engineering Education Award went to Professor Engineer Francis Gichaga.

"It was a night full of pomp, music, colour, food, and dance. Congratulations to the outstanding Engineers, and to those who were not recognized, there is always next time," she opines.

Catherine Nyambala is the Business Process Improvement Manager at KenGen PLC.


Eng Nathaniel Matalanga, CE, FIEK, O.G.W

IEK President Awarded Order of Grand Warrior (OGW) State Recognition

By EiK Correspondent

INSTITUTION of Engineers of Kenya (IEK) President, Eng Nathaniel Matalanga, has been awarded the Order of Grand Warrior (OGW) by President Uhuru Kenyatta for his contribution and leadership in championing interests of professional engineering services in the country.

During his tenure as IEK president, Eng Matalanga has been at the forefront in championing the interests of professional engineers in Kenya, notably the recent campaign to block legislation seeking to open up the leadership of roads agencies to any other professionals other than engineers.

"That there is a Bill in Parliament seeking to water down the qualifications of the director general position of the Kenya National Highways Authority and its urban and rural roads sisters, KURA and KeRRA is disappointing and baffling," said Eng. Matalanga at the height of the campaign.

"Sometimes the best way to check if you are doing it right and on the right trajectory is to assess what peers and other countries are doing. The US and UK, Japan, Germany, South Africa, Tanzania, Ghana, Nigeria, Rwanda and Australia have the heads of road authorities and agencies as engineers," Eng. Matalanga told the Parliamentary Committee at the time.

The IEK president is also accredited with championing local and international engineering collaboration, expanding academia and engineering industry linkage and collaboration with universities that offer engineering courses in Kenya and relaunching Engineering In Kenya magazine, a publication of the IEK.

Eng Matalanga has been an instrumental member of the Engineers Board of Kenya (EBK), offering sound and invaluable policy advice on professional engineering issues in the country and beyond.


(Photo Courtesy)

The Role of the President's Delivery Unit in Implementing Government of Kenya Projects

By Josephine Njeri Kamatu

Introduction

THE Government of Kenya is committed to delivering projects to the people of Kenya on time and within budget through the various ministries and State departments. Completion of these projects is at times hindered by several challenges that delay the commitment to Kenyans by the President. To assist in the delivery of projects, the President's Delivery Unit (PDU) was formed in 2015. The PDU aims at supporting accelerated delivery of development plans established in Kenya's Vision 2030 and works to support ministries and State agencies in this agenda. The main function of the PDU is to provide oversight and coordination in delivery of national priorities and flagship programmes. The PDU utilises the whole government approach as stated in the President's Executive Order No 1 of 2019. This approach organises government delivery across three levels – national, regional and county.

Functions of the PDU

A delivery unit can be defined as an entity reporting at the highest level of a government, which is responsible for putting in place a systematic approach for driving progress and delivering results in specific priority topics. The motivation behind the formation of the PDU included lack of coordination among stakeholder agencies, lack of finances among government agencies, poor performance management and lack of delivery capabilities, among others.

The functions of the PDU involve a continuous process of projects monitoring, evaluation, tracking, problem solving emerging challenges, and stakeholder management. PDU structure comprises ministry and field teams. The ministry teams support the government ministries and State departments; collect, monitor and track project information from the ministries and State departments using the Government Project Repository System (GPRS) tool; while the field teams coordinate with the respective site and county officers on the ground to ensure project completion.

Project Challenges

> The following challenges have been found to cut across projects: lack of feasibility studies, signing of non-binding contracts, expensive land acquisition, slow relocation of utilities, delayed compensation of PAPs and project financing challenges.

The PDU team is committed to assisting State agencies in solving project challenges prior to project commencement to ensure smooth and efficient delivery of projects to the people of Kenya.

There have been several success cases in unlocking challenges in projects such as the Nairobi Expressway, Nairobi Missing Links roads projects, Olkaria-Lesos transmission lines, standard and meter gauge railway connections, water and dam projects and completion of sports stadiums, among others. Involvement of the PDU in project planning would be of great significance in ensuring delivery of projects to the people of Kenya.

Josephine Njeri Kamatu is an official at the Presidential Delivery Unit (PDU)

Reclaiming Rightful Place of Professional Engineers in Kenya: Legacy of the 2020/2022 IEK Council

Members of the 2020/22 IEK Council during the launch of the Engineering in Kenya magazine on March 4, 2021.

By EiK Correspondent

THEY say winning hotly contested elections come with an attendant cost – the price of responsibility. In defence of professional engineers, they have left no stone unturned and went every mile. On multiple fronts, the members faced a myriad of challenges: professional issues, industry and academia relations, important events to run amid unraveling Covid-19 pandemic, cases filed in court by disgruntled election losers keen on scuttling processes of assumption of office – a full in-tray.

Such was the elephant task that ushered into office the 2020/2022 Institution of Engineers of Kenya (IEK) Council. Taking charge as custodians of interests of the country's professional engineers was not going to be a walk in the park. Council President, Eng Nathaniel Matalanga, only recently conferred Order of the Grand Warrior (OGW), paints a picture of the challenges that came on the horizon at the start of the Council's term and how they beat them.

As the election dust began to settle, hurdles began to emerge, defining the Herculean task that lay ahead for the newly elected Council. "My inspiration is to get things done in a proper way. My mandate (as President) is to ensure systems are in place to make IEK strong – the go-to membership organisation for engineers in Kenya," Eng Matalanga said in his election victory speech.

Reclaiming and reasserting the place of the professional engineer in Kenya has been central to this promise. The profession of engineering in the country has faced unrelenting onslaught from vested interests and other professions. "Many with vested interests who, fishing for existing legal and regulatory loopholes, have in recent times moved to enact malicious policies, at roads agencies for example, aimed at chipping away engineering-related jobs and opportunities from engineers to other professions," the President told this writer in an interview.

Eng Matalanga and the IEK Council moved with speed to take a hardline stance from the onset, defending what the Council believed were roles outrightly meant for professional Engineers in Kenya. "Let us repeat it until everyone knows it: Hire Kenyan Engineers, Build Kenya! So that we can also enforce it through policy and regulation," the President led the clarion call.

In 2021, the IEK Council swung hard into action, knocking on every door to defeat a Bill in Parliament that sought to amend the Kenya Roads Act 2011. The amendment, allegedly sponsored by parties with vested interests keen on excavating for themselves huge chunks of the cake long preserved for professional engineers, sought to open up the stringent requirement of extensive engineering experience as a prerequisite, opening up a window for appointment of non-engineers as directors general of road agencies.

Similarly, the 2020/2022 IEK Council was swift to make known its views as State-run national power utility supplier, Kenya Power and Lighting Company Limited (KPLC), began sliding into realms of corporate self-attrition. "Whenever an Engineer has been at the helm, Kenya Power and Lighting Company Ltd has always demonstrated significant stability," Eng Matalanga insists. The IEK Council vehemently condemned arrest of engineers working at the power utility following a national power blackout (See separate story).

The Council has worked hard to improve service delivery to IEK members by the Secretariat, recruiting three managers in Finance and Administration, Training and Membership, Policy, Research and Advocacy. The Council also created robust partnerships with information outlets and media houses, to help in the fight for an enabling environment for the teaching and practice of engineering in Kenya.

The outgoing IEK Council will also be credited with significantly increasing membership of the institution across all classes. From Student, Graduate, Corporate members to the upper echelon Fellows, the membership has risen significantly to nearly 10,000.

The Council at one point resolved to grant an amnesty, waiving registration fee for trained, qualified professional graduate engineers to join IEK. The institution's "Mashinani" devolution drive also saw the launch of two new branches; IEK Capital and North Rift.

> The 2020/2022 Council engaged diplomacy and advocacy strategies to raise awareness, managing to capture national attention. These efforts have not gone unnoticed, especially in lobbying members of the National Assembly. In 2021, IEK events were graced by lawmakers and political leaders of high standing.

The Council will also be remembered for ensuring professional Consulting Engineers are panelists at both IEK and Engineers Board of Kenya (EBK), ensuring that more engineers are able to transit from Graduate to Professional Class.

The IEK International Engineers Conference of November 2021 showcased the tremendous success of the Council, with a huge number of engineers and exhibitors in attendance. "Over the last three years, we have witnessed the number of those attending the IEK International Conference double each year. This has improved the quality of papers presented – as well as the number of countries participating," says Eng Matalanga.

"The vison, heading into 2030, is to grow the Institution of Engineers of Kenya to become the reference point in engineering, guiding policy development of infrastructure in this country and in the East Africa region," says Eng Matalanga with conviction.

The 2020/2022 IEK Council spared no one deemed to be infringing on the engineering profession. It challenged what it deemed inconsiderate administrative policies and decisions, not only the awarding of engineering jobs to unqualified parties by some road sector agencies, but has also constantly urged the Attorney General's office to review its legal opinion handing over engineering accreditation to Council for University Education (CUE), instead of the AG promoting collaboration with professional regulator, EBK, which needs the mandate in order become a signatory of the Washington Accord.

"The OGW state award is a deserving recognition of the efforts by everyone in the IEK fraternity who have dedicated their time and efforts towards improving the society of Engineers, and great reward for our emboldened efforts to defend engineering profession and infuse vibrancy into IEK. With it, every engineer in Kenya, no matter how young, can feel inspired and confident that whenever they are doing the right things, these efforts will be noticed and rewarded," says Eng Matalanga.

The 2020/2022 Council also counts in its basket of achievements the restart of Engineering In Kenya Magazine. Collaboration on the publication had previously stalled owing to technicalities with previous publishers. The new publication has greatly transformed access to engineering information in Kenya, with over 100,000 copies circulating bimonthly in print and digital format.

The Council is in talks with Konza Technopolis for possible partnership in the development of an engineering plaza, which will create a lot of visibility for engineers and financial stability to the Institution.

Engineers are at the Core of Crafting Developed Nations, says Eng. Lucy Wanjiku Mutinda

By EiK Correspondent

ENGINEERING in Kenya Magazine spoke to first IEK Vice President Eng Lucy Wanjiku Mutinda on the sidelines of the 28th IEK Conference in Mombasa. Here are the excerpts from the interview.

Who is Eng Lucy Wanjiku Mutinda?

My name is Eng Lucy Wanjiku Mutinda, a Mechanical Engineer by training. I also hold other qualifications, including International Leadership and Management. I run a company called Ecocycle Limited, where we do on-site waste water recycling, and I am also the First Vice President of the Institution of Engineers of Kenya (IEK).

What is your key take-away from the 28th IEK International Conference?

The 28th IEK Conference has been a great success. Its theme was Engineers Accelerating Sustainable Economic Recovery. For any country to continue developing, engineers form the foundation and core of what it takes to build a developed nation: transport, utilities, water supply, electricity, the built environment, digitisation and artificial intelligence, even medical equipment. President Uhuru Kenyatta has strongly laid out the Big 4 Agenda. It is clear Engineers are part and parcel of every facet of the Big 4 Agenda. At the 28th IEK Conference, Engineers came together to discuss the most sustainable ways of supporting the national leadership in achieving the Big 4 Agenda to accelerate the national economic recovery.

Why should Engineers in the country join and rally behind IEK?

As IEK, the first thing we have always done is create value for IEK members across all categories – from when they are students, Graduate Engineers, Professional Engineers all the way to Fellows. Secondly, as the country works towards the Big 4 Agenda, there are a lot of policy issues, including decisions on who heads what agencies. As a society of Engineers, we have been vocal and visible this past year, participating in advocating issues pertinent to engineering. We are also constantly seeking partnerships with government and private sector agencies to absorb our members, advocating transition into work following graduation after five years of rigorous training. Engineering is a profession that touches on safety and well-being, it has to be regulated.

IEK Council members, Eng Lucy Mutinda, Eng Nathaniel Matalanga, Eng Grace Kagondu and Eng Margaret Ogai.

Gender and leadership. How has IEK empowered women Engineers?

We are in this era where we have to agree that diversity, equity and inclusion is a key thing for success of anything in the world. Because women form 50 per cent of the population, any decisions taken, including in engineering, call for involvement of both genders. For a long time, the profession was known to attract a bigger percentage of men.

> As IEK, we have made significant strides towards female engineering student mentorship, especially from formative high school stage, engaging young girls to interest them in Science, Technology, Engineering and Mathematics (STEM).

Besides, the IEK through the Women Engineers Chapter has tried to reach out to mentor graduate women engineers, hence the essence of our own day at the IEK Conference, Women Engineers Summit. The Summit has been a great place to canvas professional and family-career life balance. We invite companies and corporate stakeholders to partner with IEK to expand opportunities for women in engineering. I urge all women Engineers who have the zeal and the drive to consider running for elective positions within and without IEK when such opportunities arise.

Your parting shot?

Engineering in Kenya Magazine has been a good addition to the IEK, a great vibrancy and member engagement publication. Over the past one year, the publication has faithfully been distributed to our members, digitally and physically. It has rejuvenated involvement of IEK grassroots and regional chapters, in line with the Society's aspiration of spreading involvement of professional engineers across all 47 counties. When we all read, we share great ideas.

Eng Lucy Wanjiku Mutinda is the Founder & CEO Ecocycle Ltd; Top 40 under 40 Women in Kenya, 2018

Application of modularisation techniques in construction projects with a focus on Nuclear Power Plant Projects

By Eng. Eric Ohaga, IEK 2nd Vice President

MODULARISATION is a design process where in situ work is organised into modules that can be fabricated off-site in controlled factory conditions before transportation and assembling on-site where inter-module connections tie the units together. It makes the most of offsite manufacture and economy of numbers achieved via design standardisation. Modularisation is a century-old concept that has been adopted by a number of industrialised countries, including the United States, the United Kingdom, Japan, Europe, and Australia. Henry Ford (1913) revolutionised the automobile industry by introducing the assembly line concept, which reduced construction and production time while preserving quality and control. In the 1940s, during World War II, modular construction was adopted to address the increase in housing demand in the USA. Recently, in the wake of the COVID-19 pandemic, China adopted modularisation techniques in the construction of a 1,600-bed capacity hospital in 10 days to address the surging number of COVID cases.

Figure 1 : *Huoshenshan hospital in Wuhan, China. Source: https://www.smh.com.au/world/asia/china*

Modularisation as a construction technique has been applied in a number of heavy industries worldwide. These include shipbuilding, aerospace, automotive industry, chemical process, oil and gas sector, civil construction and the nuclear sector.

Table 1 : *Application of Modularisation*

INDUSTRY	APPLICATION
Civil	• Pre-stressed and Pre-cast concrete beams, panels for bridges, commercial and residential buildings • Pre-fabricated steel structures.
Aerospace and automotive	• Production of identical modules: Automobile and aircraft parts such as Aircraft galley, landing gear equipment, etc.
Oil & Gas and Chemical	• Process pipe racks, turbine modules, heat exchangers, distillation columns, feed water heaters, I&C modules.

The modularisation technique presents several benefits; key among these is a significant reduction in project costs and lead times. However, the adoption of this technique in some industries is limited by some challenges in logistics, licensing/regulations, and planning. The benefits and challenges of modularisation are illustrated below.

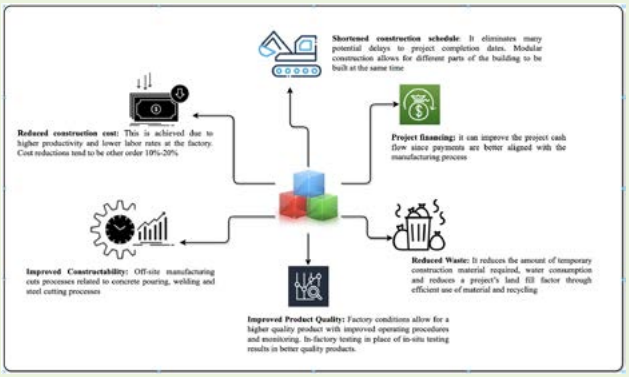


Figure 2 : *Benefits of Modularisation*

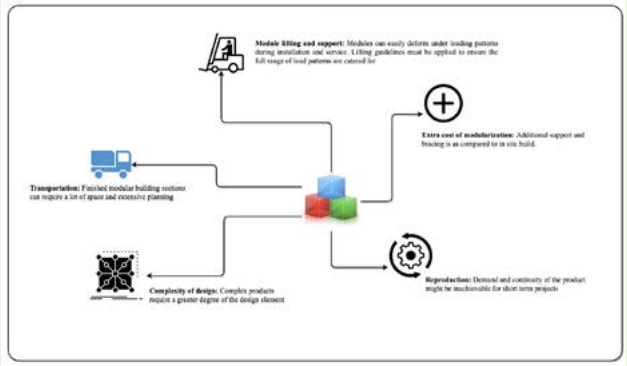


Figure 3 : Challenges of modularization

Modularisation in Nuclear Power Plant (NPP) Construction

Modular building techniques have been employed in the construction of nuclear power plants since at least the 1970s to reduce construction time schedules and costs (Stone & Webster Engineering Corporation, 1977). NPP projects have been challenged by long construction periods and high upfront construction costs compared to conventional power plants. Typically, construction of a 1000 MWe Nuclear Power Plant takes approximately 6-8 years while for Small Modular Reactors (SMR), most of which are currently at design stages, are envisioned to take 3-4 years. Currently, there are about 52 nuclear power plants under construction worldwide.

NPPs are made up of complex civil structures that are required to meet high safety requirements such as thicker walls, large number of embedded plates and higher specifications for reinforcements. This necessitated the adoption of modularisation techniques in the design and construction of NPPs consequently improving on quality, reduction of construction schedules, project costs and risks that can compromise safety. This has contributed to ensuring that NPPs are competitive with other conventional power plants.

Modularisation of an NPP commences by designing the plant as a set of separate components/subsystems that can be assembled together on site. Moreover, modularisation can also take place in process systems and in the manufacturing and construction stages. There are four general steps to achieving modularity in NPP:

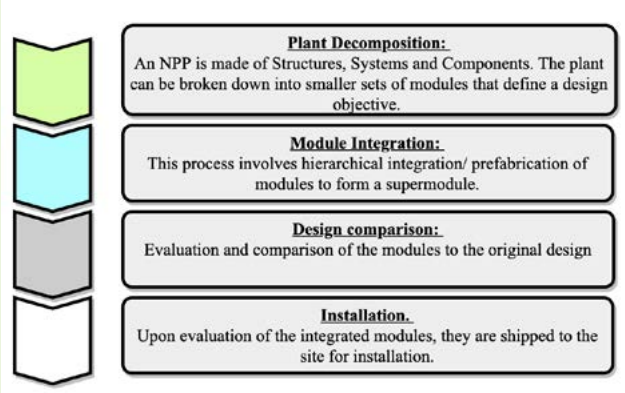


Figure 4 : General steps to achieving modularity in NPP

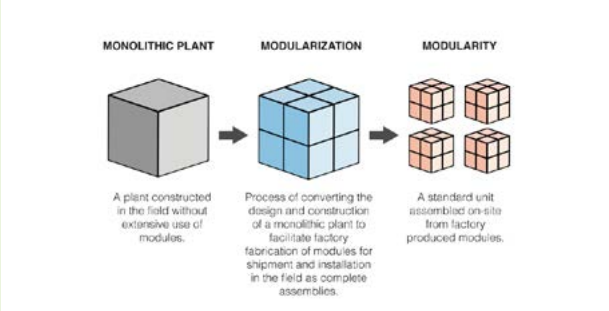


Figure 5 : Modularization process (plant decomposition to plant modules ready for assembly)

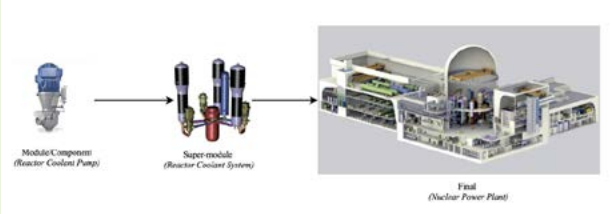


Figure 6 : Module-Super Module-Final Assembly of a nuclear steam supply system in an NPP

The degree of modularisation of an NPP is dependent on the reactor technology i.e. large NPP or an SMR. Up to 80% of an SMRs can be modularised and transported as compared to only 20% for a large NPP. The motivation of SMRs to apply modular build is to resolve existing in-situ build challenges in large NPPs and improve the competitiveness of nuclear power (Lloyd, 2020). SMR concept builds on the off-site fabrication of the structures systems, components that are transported to the site for installation. Offsite fabrication enables cost reductions and shorter build schedules increasing productivity through parallel working and standardisation. Recent research from the University of Cambridge demonstrates that a fully modularised NPP (i.e. SMRs) can result in a cost reduction of up to 20-50% and a construction time reduction of up to 25% of nth of a kind.

To determine whether a power plant project should apply modularisation and the degree to which it can be applied, the project designers should analyse specific requirements for the project such as plant location, environmental, social, regulatory and availability of labor with the required skill set to implement the project. A detailed feasibility study is thus carried out considering this multi-attribute approach and performing further studies on sub-attributes under each main attribute, should the first screening favor modularisation.

Recommendation

Engineering projects face challenges in modularisation and nuclear power projects have not been exempted. Challenges common to both industries include laxity to adapt to unfamiliar offsite production processes, restricted supply chain and location constraints. Additionally, there is a concern in achieving structural integrity, connections of modules in-situ and avoiding deformation of modules. In

module design for both industries, it is highly imperative to account for all loading patterns during transport and in-service.

There is need to adopt best practices in regards to modularization, these include:

- Ensuring physical and functional elements are fully compatible to achieve an overall result of integration.
- The module connections (joints and interfaces) must be designed to be minimal to enable rapid assembly.
- To improve the projects' repeatability, the modules should be standardized as much as possible.
- The modules should be designed early in the project cycle to ensure the time schedule is met. This also enables design changes to be made earlier to avoid replicating errors.
- Suppliers of critical components should be reliable and efficient to minimize project delays and maintain production consistency
- On-site modularization should be applied in terms of parallel construction where construction is broken down into sections built concurrently.

Conclusion

Civil housing units commonly follow conventional in-situ building techniques. To meet rising residential/commercial housing demands in Kenya, the Industry is encouraged to adopt modularisation so as to exploit the range of benefits it offers. Modularisation enables simultaneous designs and procurement to be carried out in addition to parallel construction activities. For projects with high production volumes, it provides an opportunity to benefit from repeatability and economies of scale, saving millions in labour and material costs while maintaining a controlled construction schedule. This will create competitiveness in the housing sector by employing mass manufacturing of customisable units, in a manner analogous to the automotive industry.

Eng. Eric Ohaga is the Director, Nuclear Energy and Infrastructure Development at Nuclear Power and Energy Agency (NuPEA).

Development of Industrial Parks in Kenyan Counties: Making it Work

By Dr Eng Josiah N Nyagwachi, PhD, PE, MIEK

1) Contextual Background

The Ministry of Industrialisation, Trade and Enterprise Development has identified Industrial Parks as key enablers to sustained Industrial Development and growth. Despite the existence of robust legislative and policy framework, the rate of industrialisation remains low. The output of this paper is based on desk review of previous studies and reports.

2) National Industrialisation Policy Framework

According to Sessional Paper No.9 of 2012 on the National Industrialisation Policy Framework For Kenya (2012 – 2030), the Kenya economy continued to register a positive economic growth since 2003, achieving the highest in 2007. It was then predicted that for Kenya to become a globally competitive and prosperous nation, an average Gross Domestic Product (GDP) growth rate of 10% was necessary over a period of 18 years. This required restructuring the economy through industrialisation. The policy framework was developed through a consultative framework involving the public sector, private sector, civil society, development partners and non-governmental stakeholders.

3) Alignment with Kenya Vision 2030

The National Industrialisation Policy Framework For Kenya (2012 – 2030) is aligned to the Kenya Vision 2030, which seeks to transform Kenya into a middle income rapidly industrialising country, globally competitive and prosperous nation, offering quality life to all its citizens in a secure and healthy environment.

4) The Master Plan for Kenya Industrial Development

In response to a request from the Government of the Republic of Kenya, the Government of Japan decided to conduct a study on "the Master Plan for Kenyan Industrial Development" and entrusted the study the Japan International Cooperation Agency (JICA). JICA selected a team of experts headed by Mr Yoshio NAGAMINE of SANYU Consultants INC. and KRI International Corporation, between 2006 and December 2007.

The team held discussions with officials from the Government of Kenya and conducted field surveys in the study area. A National Seminar was held in Nairobi in November 2007 to share the results of the study with stakeholders and to construct the

discussions on the report. Upon return to Japan, the team conducted further studies and prepared a final report. The final report was subsequently submitted to the Government of the Republic of Kenya in January 2008. The final product consisted of master plan, action plans and a development plan for the target sub-sectors from January 2006 to December 2007.

5) Key Recommendations (JICA Report, 2008)

Key recommendations emanating from the JICA report were:

1) Establishment of National Industrialisation Fund
2) Establishment for Commission for Industrialisation
3) Training of more professionals and artisans.

6) County Industrial Development Master Plans

According to the Kenya Engineer (Engineering in Kenya), October 8, 2013, the Government of Kenya pledged to play a key role in the development of county-based industrial enterprises as part of the national industrialisation goals. According to the then Ministry of Industrialisation and Enterprise Development Cabinet Secretary, Mr Adan Mohamed, plans were already under way to formulate county specific industrial development master plans. The plans were meant to provide roadmaps to guide county level 'industrial renaissance'.

Where We Are

7) State of industrialisation in Kenya - Overview

According to Trade, Industrialisation and Enterprise Development Cabinet Secretary (Business Daily, July 28, 2021) the ministry has completed mapping out villages and their unique products countrywide. Furthermore, the ministry is keen on growing the contribution of manufacturing to GDP from 11 percent to 20 percent. The ministry also intends to revive cottage industries countrywide, through the rural industrialisation initiative called 'one village, one product'. This will spur value addition and market access through youth – led projects.

A stakeholder's retreat was held in July 2021 to map the way forward. The stakeholders included bosses of the following:

- Kenya Bureau of Standards (KEBS)
- Export Processing Zones Authority (EPZA)
- Kenya Investment Authority (KIA)
- Kenya Industrial Estates (KIE)
- Kenya Industrial Property Institute (KIPI)
- Kenya Industrial Research and Development Institute (KIRDI)
- Special Economic Zones Authority (SEZA)

The team building retreat was among others, meant to identify gaps in industrialisation and develop a template for growth of cottage industries. Interestingly the planners of the retreat perhaps unknowingly omitted other key stakeholders such as the Engineers Board of Kenya, Association of Consulting Engineers of Kenya, among others.

Where We Are Going

8) Attract investors, setup industries and create jobs and products

According to the ministry of Trade and Industrialisation, the plan is to have functional village cottage industries in the next 12 months, through:

- Transfer of resources to the rural areas and development of strategies that will provide an enabling environment for cottage industries to grow, and
- Attract more youth into manufacturing through cottage industries in every village

9) Industrial Park Development as National Project

The industrial park development in each county is part of the Vision 2030 and must be recognised as collaborative effort between national and county governments. A dedicated fund should be setup.

10) Industrial Park Alternatives/ Models

For the development of industrial parks by counties, the following alternatives / models may be considered:

1. Direct development and management
2. Co-development and management with counties
3. Development and management by consortium of developers

For alternative 1 or 2, the development budget is normally obtained from domestic financiers or foreign donors. In alternative 3, the developer is responsible for investing in the development of the respective industrial park.

11) Land allocation or acquisition

Land for the industrial parks should be identified, allocated and properly titled. The period of lease is typically 10-30 years. Each county should review the above issues about land carefully before planning the development industrial park projects.

For alternative 1 or 2, the development budget is normally obtained from domestic financiers or foreign donors. In alternative 3, the developer is responsible for investing in the development of the respective industrial park.

12) Types of products/businesses in Industrial Parks

The type of industrial products/ services/businesses is normally informed by preliminary survey results and recent trends in the local and international markets. Some examples include:

- Food products
- Beverages

- Textiles
- Clothing
- Stationary
- Wood
- Paper
- Media production
- Fabricated metal
- Transport
- Services
- Electrical, among others.

13) Industrial Park Infrastructure

Leveraging expertise / outsource or partner with a pool of professionals to plan, design and construct infrastructure:

- Roads and drainage systems
- Water supply
- Sewerage
- Electricity
- Telecommunications

14) Industrial Park Implementation

To secure developer(s) for the development and management of industrial parks, RFP (request for proposals) documents for bidding of developers need to be prepared and published according to the procurement policy.

15) Consultancy Services

Each county is required to develop and publish terms of reference for consultancy services for provision of consultancy services.

The objective of the consultancy include:

a) Carrying out feasibility study on the proposed industrial park sites

b) Develop a Master Plan giving detailed plans and realistic budgets for the provision of basic infrastructure to support the industrial parks

c) Produce prototype models for the identified industrial parks

d) Detailed engineering designs and drawings for all infrastructure
   - Roads
   - Power
   - Water
   - Sewerage treatment plant (where required)
   - Solid waste facility
   - ICT fibre optic
   - Parkin areas, and
   - Public open space.

e) Develop marketing and promotional plans to attract investors

f) Develop financing models and funds mobilisation strategies

g) Develop roadshow presentations

h) Develop and appropriate management model for success

i) Carry out a cost benefit analysis for the industrial park

j) Develop Action Plans/ Implementation Plan and cost implications

16) Management of Industrial Parks

For successful planning, design and implementation of industrial parks, each county should do a careful study specific to its environment. The national government may assist by providing a template for different types of models. The functions of the management body may include:

- Investment promotion
- One stop service centre
- Environmental
- Business support services
- Amenity services

17) Expected Contribution

As a university lecturer and practising engineer, Nyagwachi found it necessary to develop this document to promote industrialisation in Kenya and contribute to jobs creation for young engineering and technology professionals.

18) About the Author

Dr Josiah Nyagwachi is a professional civil engineer with extensive knowledge and practical experience, having worked both in public and private sectors (Diaspora and Kenya). Nyagwachi holds a PhD degree in Construction Management, Master of Science in Applied Science – Project Management and Bachelor of Science in Civil Engineering. Besides holding these formal qualifications, Nyagwachi is actively engaged in the progression of the engineering and construction project management professions, as well as PPP expertise, through teaching at the Technical University of Kenya and consulting as a Professional Engineer at Mandaso Projects.

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Electrical Engineering in Built Environment; a Forgotten Prerequisite Towards Affordable, Sustainable, Safer and Comfortable Housing

By Eng. Joel Nadebu

> Electrical services will make the project too expensive; they will be installed upon completion of the project.

This phrase commonly comes up during initiation of housing projects. While this statement may tend to be true at the initiation stage, most developers and consultants tend to regret upon completion of projects without incorporation of electrical engineering services. Incorporating these services at the completion stage makes the project even more expensive. This challenge can also be attributed to the fact that some developers or consultants fail to engage professional electrical engineers in projects. It is worth noting that the only person competently allowed to advice the developer on matters electrical engineering services is a professional electrical engineer and not an architect, structural engineer, mechanical engineer, interior designer or quantity surveyor. In this article, we shall look at why electrical engineering services are a necessity for affordable, sustainable, safer and comfortable housing.

Power systems and energy efficiency

This involves lighting, power outlets, heating, cooling and other equipment using electrical power. On lighting, most stakeholders tend to look at aesthetics of the luminaires and general terminology of "LED energy saving fixtures", while forgetting other factors like power, life hours and illumination levels of the luminaries vis a vis international approved standards on space illumination levels, which can only be well addressed by a professional electrical engineer. A poorly designed lighting system will make the project unsustainable during usage, with high bills from Kenya Power PLC. Some users opt to switch off their lights, including security lights, to reduce bills.

Power outlet points are essential for housing projects based on the load requirement of the client and it varies from one client to the other. In most cases, stakeholders tend to think of 13A sockets as the only power outlets. However, different equipment and machinery have different power needs. For instance, some kitchen equipment use three-phase power for operations. Load calculations, cable sizing and appropriate switchgear protection or circuiting would require an input of a professional engineer on a case-by-case basis.

Automation systems

The modern day housing automation and smart buildings solutions are on the rise courtesy of advanced technology and innovations. Home automation ranges from lighting, HVAC, security, access control and IoT systems. Building automation helps in effective energy management, timely maintenance and interactive response to visitors remotely. These services require infrastructure like cabling and routing, hardware and software well integrated for proper functioning. Design and installation of these services can only be guided properly by a professional engineer.

Vertical transportation

Most housing projects in urban set up are equipped with elevators for access and transportation of traffic from lowest level to higher levels. The specifications of such systems in line with international standards and local regulations can only be given adequately by a professional engineer.

Fire detection and alarm systems

Fire hazards can cause a loss to housing projects at any stage (during construction or occupation). Fire detection and alarm system is made up of sensors, actuators and processors. A professional electrical engineer can elaborately handle the design of these systems. Most clients and consultants tend to prefer firefighting systems to fire detection and alarm system. Fire can be successfully fought if it is detected at its earliest possible occurrence.

In conclusion, electrical engineering services should be adequately planned for at the initiation of housing projects. This will make the project efficient and comfortable for occupation.

The writer is a Senior Superintending Engineer (Electrical) at State Department for Public Works, Nairobi.

Roads that Shall Build Kenya

By Clinton Maroria Rosana

THE economic resources available in any country are the fundamental factors that influence its growth (Ivanova, & Masarova, 2013). Road infrastructure has been for the longest time considered as the key prerequisite of social and economic development of any nation. China, for instance, has grown to be one of the world's strongest economic powers because of their slogan, "If you want to get rich, build roads first" (Chen, 2021). Through the Belt and Road Initiative (One Belt, One Road), China is working to promote interregional connectivity for more than 115 countries, and this will directly boost the country's economic development. The United States is another example of how roads can have a highly significant impact on the economy of a nation. Dan McNichol, in his book *The Roads that Built America* narrates how America learnt lessons from World War II on the necessity of superhighways for transport and movement. McNichol further narrates how today, the U.S has the most incredible road system in the world. America's Interstate Road System is believed to be one of the largest engineering projects the world has ever known. Many research studies have evidenced roads to be a vital element in any country's development agenda (Ng, et al., 2019; Gibbons, et al., 2019; Berg, 2015). Part of Kenya's development agenda and the Vision 2030 is to construct and rehabilitate roads all over the country as way of boosting economic growth. These roads shall build Kenya to its development agenda.

In order to achieve the Vision 2030, Kenya has laid down strategies to improve its road network. These strategies include various programmes such as the Expansion of Roads Programme, Roads 2,000, and Roads 10,000 programmes. Under these programmes, the country aims at constructing, upgrade, and maintain over 200,000 kilometers of road by the year 2030. Part of these roads are major corridors or road projects which, after implementation shall "build Kenya."

Just like the Belt and Road Initiative in China and the Interstate System in the U.S.A, there are five major road systems in Kenya that will enhance connectivity between the country and other countries in the region; consequently, Kenya shall grow to realize its industrialization vision. These major road projects include: The Northern Corridor Transport Improvement Project (NCTIP), East Africa Road Network Project (EARNP); Eldoret-Kitale-Lodwar-Nadapal road project, The Lamu Port-South Sudan-Ethiopia-Transport (LAPSSET) Corridor project, and The Horn of Africa Gateway Project. The construction and completion of these major corridors will not only facilitate trade and specialization of tasks between Kenya and her neighbors in the region, but also foster economic growth and industrialization of the country.

The first road project that shall build Kenya is The Norther Corridor Transport Improvement Project (NCTIP). NCTIP is a World Bank financed project to improve the Northern Corridor - "the transport corridor linking the Great Lakes countries of Burundi, D.R. Congo, Rwanda and Uganda to the Kenya sea port of Mombasa. The corridor also serves Northern Tanzania, Southern Sudan and Ethiopia" (Northern Corridor Authority, 2004). The second road project that shall build Kenya is East Africa Road Network Project (EARNP). EANRP is a road improvement project in Kenya as well which is similar to China's Belt and Road Initiative. It is a 'Silk Road' project through the East African countries whose objective is to connect the Norther Corridor with the Central corridor that originates at the port of Dar es Salaam in Tanzania (Oirere, 2021). The Eldoret-Kitale-Lodwar-Nadapal road project originates at Eldoret town and ends at Nadapal town in South Sudan. This project aims to promote and enhance economic integration between Kenya and South Sudan. The LAPSSET Corridor project was conceived in 1975 and later revived and included in the Vision 2030 agenda. The project aims to open up the larger part of the under-developed norther frontier through this transport corridor. Lastly, The Horn of Africa Gateway project is an Isiolo – Mandera Highway road project whose objective is to open up the underdeveloped North Eastern Kenya and also connect Kenya to Ethiopia, Somalia, Eritrea and Djibouti providing an important linkage for the country (Ali, 2021).

All these major road networks and projects in Kenya form an integrated transport system that connects almost all parts of the country. The roads are linked to each other at some locations forming a network that opens up the country and connects it to other countries in the region and after. Together, the major road projects form a web of national and international trunk roads that shall "build Kenya."

Clinton Maroria Rosana, GE EBK, GIEK, Assistant Engineer, Kenya National Highways Authority (KeNHA). Email: rosanaclinton@gmail.com

Keynote Address by Chairman of KeNHA Board of Directors, Eng. Wangai Ndirangu during the IEK President's Dinner, on December 21, 2021

Above and right: Sections of the Nairobi Expressway that is under construction.

PRESIDENT, Fellow Engineers, from time immemorial Engineers have distinguished themselves by knowledge, skills and creativity. From darkness to light and, formless to formidable forms. Everyday translating society's dreams to reality, with engineers it's a whole new world, everyday. Hard to imagine a world without engineers. I am persuaded, President that it would be without form, distant, elemental and untamed.
While some need to repeatedly remind us of their learning, the work of engineers proclaims that distinction. If ever such phrase applied, not by words but deeds, then it certainly would about engineers. Can we then afford any semblance of modesty on a night such as this!

Mr President, Fellow Engineers,

Sadly, and despite the overwhelming evidence of the capabilities of engineers, this year has witnessed continued affront to the roles of engineers. Claims that engineers cannot manage what they create or their own creative energy. Mr president, I applaud you and your members for standing up for the reputation of the profession. Beyond all this, for raising the effectiveness and visibility of IEK through communication, collaborations, social programmes and neutral forums for peer engagements. I am confident that these efforts have created more harmonious, participatory and stimulating environment for members. The level of participation at the recently concluded IEK Conference in Mombasa speaks how successfully the IEK Council has mobilised and stimulated members' participation.

In the coming years and in order to grow the fraternity, the Council might focus more attentions to the welfare of engineers, including scale of fees, non-practice allowances, housing development for willing subscribers and relief support.

President and Fellow Engineers,

I recognise the role and contributions of female engineers in Kenya. Their participation has added flavour to the practice of engineering, both hard and soft. Their abilities and competences have earned them respect among peers. This is made obvious considering that women engineers are fewer than their male counterparts, yet hold 50% of leadership positions in the IEK Council.

On the same breath, I applaud men in IEK for believing in women leadership. They used their majority numbers and positions to entrench a more equitable environment for engineering professionals, where everyone, young and old, male or female, public and private, is acknowledged and supported.

Mr president, Ladies and gentlemen, lets us acknowledge and applaud our Young Engineers who work hard for a better life, a better world. We celebrate their vibrant and dynamic attitude.

We celebrate with pride, the Eminent Engineers for the constant words of counsel and availability to guide the future. They have remained our beacon of hope and stability.

I salute the upcoming leaders of the fraternity. It warms my heart to note the recognition of our KeNHA staff, Eng Ezekiel Fukwo and Eng Joan Otike, for their leadership in mentoring young engineers. Their effort is part of shared value of all all us at KeNHA.

We value the work of all the engineers working in the public and private sectors. Their work in contribution to the National Development Agenda, and in particular, the achievements of the Big Four Agenda and Vision 2030. By spearheading the construction, operation and maintenance of both big and small infrastructure projects in roads, railway, water, housing, energy, agriculture and industries, among others, we have made a difference in the realisation of our social-economic development vision.

I salute Engineers in policy and management. Through development of robust policies and corporate leadership, they are at the core of running of this nation. They have done us proud.

Engineering educators and knowledge generators continue to expand frontiers of engineering knowledge and practice. We see more graduate engineers coming out of our training institutions and better consolidation of research and innovation.

I wish to acknowledge the Engineering Board of Kenya (EBK) for the various efforts and initiatives in rationalising our practice. I know EBK is working on a modality of enhancing engineering remuneration through establishment of a standard payment model. I also know the effort being undertaken to enhance the Graduate Engineers Programme among many other initiatives.

Ladies and Gentlemen, allow me to highlight a few issues for the New Year and the future. Increasingly we are living at a time where the complexity of our work demands that we devote more time to planning than implementation. We have moved to the realm of outcome-based more than input-based approaches. This therefore demands that our preparation determines our outcome. We all know the Pareto Principle of 20/80. But the desired outcomes will only come to be through well-defined processes that are anchored in well-founded values or belief. Values guide processes and processes define outcome. At KeNHA our values – teamwork, innovation and accountability – are the foundation of our work processes and consequences.

Secondly, we are operating in an environment of high ethical requirements and as a profession our work output has either contributed to the enhancement of ethical practice or been inducted for our failures. This has necessitated the need for us to stand out at a personal and professional level in enhancing ethics.

Thirdly, we continue to see the production of graduate engineers and efforts to enhance their skills. Our youth are the future we want to see; therefore, I call upon each one of us to individually mentor at least two young engineers.

Fourth, the establishment of devolved structures of government, is one among the most important changes in the delivery of essential services, including water, health, environmental conversation and food production. To blame the counties for lack of engineering professionalism is to admit collective failure in addressing the capacity needs of important institutions of public administration. Engineers need to work at the counties and the counties require adequate number of qualified engineers.

President, Fellow Engineers,

Work environment is split between people who earn their income by the services of their labour and others who simply come to get income. Engineers earn their income by providing solutions to our society's problems – problem-based approach to work. Indeed, there are still very many challenges facing us.

- 20% food losses and seasonal availability
- High cost of infrastructure
- Underutilised groundwater sources
- Trade in unprocessed commodities
- Low agricultural mechanisation
- Low connectivity to water, electricity and waterborne sanitation services
- Endemic drought and flood disasters
- High capital hill for infrastructure projects and challenges of cost recovery
- Pollution
- Inadequate housing

To elaborate a few of these challenges, waterborne sanitation in Kenya stands at approximately 21%. Several recent dams' construction costs over Ksh400 per cubic metre reservoir storage compared to less than Ksh20 observed under more efficient planning now and in the past in different African countries. Recent studies show that 90% of investment in water pans is lost within 3-5 years from siltation, otherwise these structures store water for less than 25% times in a year owing to poor planning, infiltration and/or evaporation.

Mr President, there are still too few technological and management innovations than required to address these challenges.

Lastly, we acknowledge we are going to an election year, and as both Kenyans and engineers we have a patriotic duty to be involved in shaping the conversation. This will ensure matters of development progress and a voice of conscience is part of the political narrative. I am happy to note that over the years our professionals have offered themselves for elective seats, which has enhanced our contribution to the development agenda of the country.

Ladies and Gentlemen,

As I end, allow me, on your behalf, to thank the various institutions that have supported IEK, which has enabled the Institution to undertake its various activities. I challenge that we continue to and even further enhance our support to IEK so that ii can stand tall among its peers.

Affordable Housing in the 21st Century and its role in sustainable development


(Photo Courtesy)

By Ivy Mwango Getanda,

Background

THE basic needs of every individual are food, clothing, and shelter. Affordable housing is therefore essential for the sustainable development of a country. Adequate, affordable, and safe housing as stated in Sustainable Development Goal (SDG) number 11 – sustainable cities and communities – leads to benefits in health, education and economic opportunities.

Adequate shelter means more than a roof over one's head. It also means adequate privacy; adequate space; physical accessibility; adequate security; security of tenure; structural stability and durability; adequate lighting, heating and ventilation; adequate basic infrastructure, such as water supply, sanitation and waste management facilities; suitable environmental quality and health-related factors; and adequate and accessible location with regard to work and basic facilities, all of which should be available at an affordable cost.

Methodology

Primary and secondary data was reviewed from the State Department for Housing and Urban Development, Kenya, with the aim to review the Housing survey done from 2012 to 2013 and analyse the households by type of dwelling units, housing adequacy and affordability, durable cost-effective construction materials and financing of housing in both rural and urban areas.

The UN-Habitat Global Housing Strategy Framework Document was also reviewed and analysed using qualitative techniques.

Results and Discussions

From the data on Housing survey in Kenya, 2012/2013, the cost of housing with reference to income per capita is key for affordable housing to individuals. Dwelling units in urban slum areas consisted of poor building fabric in a congested area while those in rural areas had the same building materials but in a spacious area. The cost per unit of every construction material eventually affected the overall cost of the housing project. Individuals in rural areas adopted other alternative building materials such as Stabilized Soil Blocks (SSBs) to save on construction costs.

Affordable and Sustainable Housing Techniques

The following would help make housing affordable to communities: The use of cost-effective housing materials such as expanded polystyrene (EPS) panels, pre-cast wall panels and flat beams, interlocking blocks and beam to block flooring slab technology, providing housing near public transport, infrastructure and community facilities, use of incentives and prioritisation planning, management and developmental control of slums. Analysis on cost of land and cost of materials per unit also affects the cost of Housing; waivers, subsidies and incentives offered with this regard by the Government make houses more affordable to low income communities.

Sustainable Housing involves:

1- Design: Functional and cultural adequacy, energy efficiency, climatic and environmental appropriateness, affordability, and flexibility for expansion and for upgrading of standards, adaptability for future needs, should be maximized in housing design, both at the building level and at the neighborhood.

2- Technologies: As in the case of design, the aims should be energy efficiency, environmental friendliness, cost minimising, allowing incremental expansion and improvement of standards, and enabling, where appropriate, owner building, and use of local labour and contractors. Traditional technologies should be considered for local use, and their adaptations for better performance should be encouraged.

3- Materials and components: It is important to maximize, the use of local material and components. Striving for climatic appropriateness, energy-efficiency and environmental friendliness of the production processes of building materials, and for the energy efficiency of their use.

Slum Upgrading

Slum upgrading is improving physical and environmental conditions, as well as the provision of infrastructure and services, in the areas considered slums, and incorporating them into the mainstream city. It usually begins with the survey of actual conditions followed by the planned rationalizing of layouts of individual plots (land readjustment) in order to enable introduction of streets and land required for introduction of infrastructure and services. For a successful process at the initial stages, there must be a fully community-driven participation. An Environmental and Social Impact Assessment Report is prepared during the preliminary stages to ensure the environmental needs in the proposed site are adhered to. Introduction of infrastructure, basic services and availability of adequate and affordable construction materials and components are provided to the proposed Social/ Affordable Housing Units in a slum.

An example of such a project is the Proposed Social Housing and Associated Civil Works at the Meteorological Site – Mukuru Slum by the Government of Kenya. The demand for residential space development situation in Kenyan urban areas has remained under tremendous pressure, leading to the development of informal settlements that suffer challenges of congestion, poor sanitation and indecent housing, especially in big cities like Nairobi.

For some informal settlements in Nairobi including Mukuru slums, the congestion for such an informal settlement poses serious challenges in light of a pandemic like the covid-19. It is cognizance of this that the Government of Kenya through its State Department of Housing and Urban Development and Nairobi Metropolitan Services initiated the process of redeveloping the Mukuru Slum.

This project is intended to provide decent, affordable housing and associated physical and social infrastructure for the Mukuru slum residents especially during the Covid-19 pandemic which was feared may spread rapidly in the slum as a result of poor sanitation and lack of basic social and physical infrastructure.

Conclusion and Relevance towards achieving SDGs

We consider affordable housing materials, reduced housing costs by the Government through incentives and subsidies and slum upgrading as key elements to achieving sustainable cities and communities through SDG 11.

Ivy Mwango Getanda, Jomo Kenyatta University of Agriculture and Technology
Attaché: State Department for Housing and Urban Development

IEK puts a smile on many faces with Christmas Cheer

EVERY end of year, the Institution of Engineers of Kenya, through the capacity Building and mentorship committee organizes the IEK CSR activity dubbed "Christmas Cheer". The member funded initiative by the IEK branches across the country, the Christmas cheer is centered around giving back to the less fortunate in the society during the festive season, spreading the true Christmas spirit.

From the new kid on the block (capital branch) to the veterans (Coast branch), Engineers in mashinani gave generously towards the countrywide charity drive in 2021 making it an astounding success the 5th time round.

Other than the goodies and physical gifts that engineers shared wherever they went, they freely interacted and shared about the day to day work of an engineer. Giving practical examples and breaking down complex theories, the engineers indulged the excited and young inquisitive minds they met, inspiring the future generation of problem solvers!

NAIROBI

NORTHEASTERN

NORTHEASTERN

NORTHEASTERN

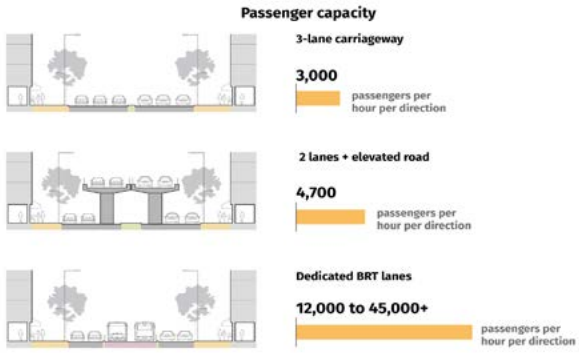
Enhancing the Viability of Bus Rapid Transit in Nairobi

Level boarding allows for ease of movement and reduces the amount of time that the bus needs to remain stopped at the station.

By Carolyn Mimano

CITIES across Africa have been planning and developing bus rapid transit (BRT) systems to improve the efficiency of public transport and give commuters an alternative to sitting in the jam. BRT is attractive because it allows a large increase in public transport capacity at relatively moderate costs compared to commuter rail or metro systems.

BRT enables cities to carry a large number of passengers without an exponential increase in road space requirements. A single BRT lane with articulated buses can carry 13,000 passengers per hour per direction (pphpd), and if passing lanes are added at stations, the capacity increases to 38,000 pphpd. The same lane can carry 800 cars per hour—only 1,200 to 1,600 persons at typical occupancy rates—assuming that the lane receives one half of the signal time at intersections.



A single BRT lane with articulated buses can carry 13,000 passengers per hour per direction (pphpd), and if passing lanes are added at stations, the capacity increases to 38,000 pphpd.

Successful BRT systems need well-planned infrastructure in line with existing and future demand patterns. Information on passenger movements is key in determining the corridor infrastructure, BRT routes, BRT fleet, bus frequencies, station locations, and station sizing. Infrastructure design should support the value proposition of efficient, reliable, affordable and shorter commutes, prompting residents to switch from private vehicle and paratransit use.

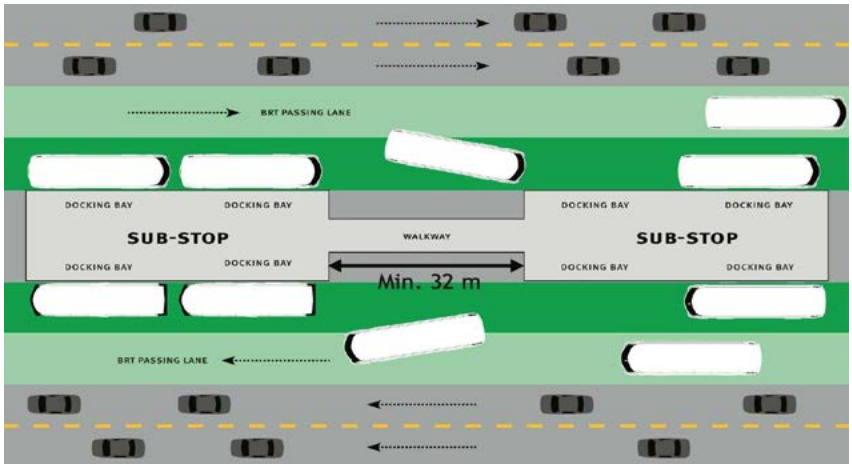
Dedicated median aligned BRT lanes with physical barriers ensure that BRT lanes are not used by regular traffic. The dedicated lanes allow for quick, timely, and efficient movements. Median lanes ensure there is no conflict or delay caused by vehicles turning onto side streets or into adjacent properties. In Accra, Ghana, when the government lacked the capital to invest in continuous dedicated bus lanes, mixed traffic movements led to fierce competition between the newly launched Aayalolo bus service and other paratransit operators, who would use the bus stops and bus lanes marked for Aayalolo in the absence of security personnel. Competition for passengers at bus stops delayed commutes and as a result, the system lacked scheduled efficient service and had no advantage over private vehicles or regular paratransit.

For corridors with high demand, such as Nairobi's pilot BRT line 2, which runs along the Thika highway and enters the Central Business District (CBD), planning should prevent delays and bottlenecks at stations and intersections. To reduce station congestion, high demand stations need passing lanes. The Nairobi line 2 service plan estimates that the system will carry 550,000 passengers per day. Passing lanes allow for express services, which offer faster commercial speeds than all-stop services and reduce station congestion further. On Thika Road, many buses and matatus already offer semi-express service, so the BRT needs passing lanes to be competitive with these routes.

Station sizing depends on the bus frequency and the level of passenger demand. Stations with high demand require multiple independent docking bays (sub-stops) to ensure efficiency and speed while increasing capacity. Stations must be long enough to allow the sub-stops to function independently of one another. The distance be-

tween the independent sub-stops should be at least 1.8 times the bus length (32m for an articulated bus) to enable buses to manoeuvre easily. Space should be reserved in the median for the addition of new sub-stops based on the future growth in passenger demand.

A well-designed BRT system enables the majority of commuters to reach their final destinations with few or no transfers. One way to do this is by offering direct services that extend beyond BRT corridors. For Thika Road, a dedicated corridor is needed along the 16km in the core city, where congestion is most severe. Direct services would pick up passengers from residential areas such as Zimmerman, Mwiki, Ruiru, Juja, and Thika, and then enter the dedicated corridor. In the city centre, direct services would extend to Westlands and Upper Hill, thereby allowing passengers to reach their destinations without making a transfer in the CBD.



Sub-stops function independently, thereby increasing the capacity of a station. The minimum gap between sub-stops is 1.8 times the bus length, or 32m for articulated buses.

Representative design of a station with multiple sub-stops on Moi Avenue near Kencom.

A BRT station should contain ramps, a fare collection area, and a boarding area. Ramps should be constructed in tactile paver blocks and with a slope not exceeding 1:12, making it convenient for people with disabilities. The fare collection area should contain system information displays and a place for customers to recharge smart cards and make enquiries. Passengers tap their smart cards or smartphones at turnstiles and proceed to the boarding area. The boarding area should provide space for people waiting for buses as well as circulation space for people entering or leaving the station. For small to medium stations, bus docking positions in either direction can be staggered, reducing the required width of the station and for easy circulation of people inside the station. The station platform height should be the same as the bus floor height. Level boarding allows for ease of movement and reduces the amount of time that the bus needs to remain stopped at the station.

In the Nairobi CBD, where BRT buses will pass through several intersections, signal cycles that prioritise BRT movements can be implemented to minimise delays and disruptions. Right turns across BRT lanes should be avoided to reduce intersection delays. Instead, vehicles can make a series of turns and then cross perpendicular to the corridor. In this way, signal cycles can be limited to two phases.

Non-motorised transport access is crucial in order to provide seamless pedestrian connectivity. Footpaths should have at least 2m of clear space for walking, with wider walkways provided in activity centres such as Githurai. To enhance last-mile connectivity, BRT corridors should also include cycle parking areas at all stations and dedicated cycle tracks constructed with asphalt or concrete and physically separated from mixed traffic.

Well-designed BRT infrastructure can ensure fast and efficient operations by preventing delays. Operational efficiency in turn determines the competitiveness of a BRT system and ultimately the willingness of users to switch from private vehicles, leading to improved access for all.

The writer is an officer at ITPD Africa

Glitz, Glamour and Sumptuous Dinner as Women Engineers End Year in Style

By EiK Correspondent

THE 2021 Women Engineers Summit Dinner went down in glam and style, as women engineers turned up to celebrate an evening of fun and inspiration. And they did not disappoint. They turned up in glamourous dress and style. The event was sponsored by various stakeholders, including Centum, Safaricom, Engineers Board of Kenya (EBK) CEO Eng Margaret Ogai, GE Abdifattah Jama, Eng Christine Ogut, among others.

Institution of Engineers of Kenya (IEK) President, Eng Nathaniel Matalanga, used the occasion to urge for increased participation of women engineers in frontline leadership roles while also pitching for the strengthening of empowerment for men so no one is left behind.

The IEK CEO, Eng Linda Otieno, made an inspiring speech, highlighting triumph of women engineers in challenging career spaces and on the home-front. "Mine is the story of every lady Engineer. I am a woman, a mother and an engineer – determined to serve, succeed and give my best," she said.

Nyeri Deputy Governor Caroline Karugu urged young women engineers to invest early in life so as to attain financial stability in old age. She also advised women engineers to invest in side hustles that generate income, away from day-to-day jobs, to cover for unforeseen circumstances in the course of their careers.

Women Engineers Summit Chair, Eng Christine Ogut, called greater involvement of young women engineers in leadership contests, while rooting for women engineers to support each other to succeed. The highlight of the night came in the remarks of Suba South MP Millie Odhiambo Mabona who urged women engineers to viciously fend-off career detractors both at home and at the work place.

"Grace, fire and power are inherent traits you must harness as a career woman to tame your detractors and succeed. As a career woman engineer, you must recognise unfolding bad circumstances early enough and turn them to your advantage by demonstrating you are much more than what your detractors say. When they present you with bad energy and try to bring you down as a woman either at home or at work, stand up for yourself and return to sender," said the lawmaker.

Women Engineers join Suba South MP Millie Odhiambo, Engineers Board of Kenya CEO Eng Margaret Ogai and IEK President Eng Nathaniel Matalanga pose for a photo moment at the 2021 Women Engineers Dinner.

Dazzling women engineers keenly follow proceedings at the IEK Women Engineers Dinner in December 2021.

MTRD

MATERIALS TESTING & RESEARCH DIVISION

Eng. S.K. Kogi
Chief Engineer (MTRD)
State Department for Infrastructure
Materials Testing and Research Division

Materials Testing and Research Division (MTRD) delivers its mandate through key functions including research, development of standards, performance monitoring, project design and construction quality control and testing services.

Our main focus is facilitating the development of quality, safe and sustainable infrastructure both at National and County Government levels. We also provide services to the private sector and are available for consultation by the general public. With increase in demand for services and the need to have a footprint in all the 47 counties, the Division has embarked on various programmes for capacity building.

Currently, the World Bank is providing support to the Ministry to transform MTRD into a Semi-Autonomous Government Agency by June 2023.The Division is ready for the transformation with enough capacity and adequate structure including a diverse human resource and state of the art equipment.

The Head Office and Central Laboratories are located in Nairobi's Industrial Area, along Machakos Road. There are eight specialized laboratories at the Headquarter viz:

Bitumen Laboratory: Physical analysis of bituminous products and mixes used in road construction for performance and compliance to standards and specifications.

Building Materials and Concrete Laboratory: Testing of building and road construction materials such as sand, aggregates, cement, concrete, steel reinforcement bars, building stone and concrete precast units.

Foundation and Drilling Laboratory: Soil/rock investigations (geotechnical) to provide information necessary in determining foundation depth and safe bearing capacity for bridges, dams and buildings.

Soils Laboratory: Physical analysis of soils for road construction which includes classification, compaction and strength tests.

Paints Laboratory: Testing of cold and hot applied thermoplastic road marking, decorative and automotive paints. Evaluation of road furniture including road signs and studs.

Chemistry Laboratory: Chemical analysis of building/ construction materials, industrial raw materials and products to ascertain quality and compliance to standards.

Physics Laboratory: Physical testing of engineering and non-engineering materials for compliance with standards and specifications. Also, non-destructive testing of structures, parts and fabricated works for structural and mechanical integrity

Traffic Surveys and Pavement Monitoring Laboratory: Performance monitoring of pavements through surface condition surveys, traffic studies and structural condition surveys.

MTRD REGIONAL LABORATORIES

There are also 16 regional laboratories located in **Bungoma, Eldoret, Embu, Garissa, Kakamega, Kerugoya, Kisii, Kisumu, Machakos, Meru, Mombasa, Murang'a, Mwatate, Nakuru, Narok and Nyeri.**

OUR VISION, MISSION AND MOTTO

Vision

To be a world-class institution for testing and research on roads and other infrastructure.

Mission

To facilitate development of quality roads and other infrastructure through testing, research and advice on construction materials, methods and delivery options.

Motto

Quality and Safety

OUR FUNCTIONS

- Provision of laboratory & testing facilities for prospecting, examination and testing of construction/building materials, geological and geotechnical investigations, geospatial surveys, hydrological and hydraulic studies, traffic surveys and studies;
- Construction quality control oversight, public roads pavement performance monitoring and evaluation;
- Non-Destructive Testing of infrastructure including buildings;
- Testing, calibration and verification of precision instruments, gauges, scientific apparatus, and other laboratory/field measurements equipment;
- Certifying civil engineering laboratory technicians;
- Review of pavement designs for construction and rehabilitation of public roads;
- Collection of data and maintenance of databases for pavement construction for public roads;
- Research on infrastructure development, maintenance, operations, materials and methods;
- Development and review of materials testing standards, review of pavement design manuals and standard specifications for road construction and maintenance; and,
- Advise the Government on material usage on construction, maintenance and operation standards

RESEARCH AND INNOVATION

Road Construction Materials

Research and development for road construction materials has evolved since the 1970s. A study on Kenyan soils and gravels was carried out on profiling and characterization of materials to facilitate development of standards, design procedures and specifications for construction of roads to paved standards including gravel roads.

However, challenges in construction, operation and maintenance of both paved and gravel roads have been encountered due to depletion of natural road construction materials sources.

To overcome the challenges, the Ministry through Division has successfully tried some various thematic approaches to alleviate costly and inefficient projects, namely:

1) Trials on labour intensive and cost-effective materials for Low Volume Sealed Roads;

2) Prospecting and mapping of road construction materials;

3) Studies on slope stability incorporating geosynthetics and reinforced earth walls;

4) Trials on harder bitumen, polymer modified and performance grade bitumen; and

5) Use of Hydraulic Road Binders (HRBs)

The Pavement Design Guideline for Low Volume Sealed Roads (LVSR) was published in April, 2017 and its use has enabled design and construction of LVSR in the rural areas.

The research data collected over time will be useful for the review of our Road Design Manual and Standard Specification.

Review and Updating of the Road Design Manual and Standard Specifications

The process of reviewing and updating the Kenya Road Design Manual and Standard Specifications is ongoing. The road and construction standards currently in use were proposed and drafted in the 1970s and 80s. However, most of the standards remained in draft form and some were yet to be drafted. A few of the standards were finalized and published.

Considering the large road network and predominant nature of road transport in Kenya, the review and updating of the existing standards is necessary to obtain appropriate manuals that incorporate modern road construction and maintenance technologies, integrate motorized and non-motorized traffic demands and take into account recent changes in vehicle specifications such as size, carrying capacity and axle configurations.

Section 18(c) of the Fourth Schedule of the Constitution of Kenya assigns to the National Government the functions and powers of setting standards for the construction and maintenance of all public roads including those under the jurisdiction of the County Governments. The Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works was therefore mandated to develop and update standards for road design, construction, maintenance and operation of public roads.

Through the Kenya National Highways Authority (KeNHA) and funding from the African Development Bank (AfDB), the Ministry procured a consultancy contract for the review and updating the road design manuals and the overall aim of the consultancy is to assist the Ministry to review and update the Kenya road design and construction standards to incorporate best practice, climate change considerations and recent technologies that enable cost effective and efficient implementation of road development and maintenance projects and safe, secure and efficient road transport system.

To ensure delivery of the desired manuals that are fit-for-purpose a comprehensive project oversight structure comprising the National Steering Committee, Technical Administrators, Project Coordinator and Technical Task Force has been established. The oversight team is drawn from various institutions in the Roads Subsector and other relevant government entities.

The assignment will also focus on stakeholder engagements including organization of workshops with the aim of facilitating stakeholder participation and input on documents prepared by the Consultant.

The review process is expected to be completed by May 2023 with the launch and dissemination of the updated manuals and standards.

Quality & Safety

CONTACT US

Any enquiries on services available should be made at the earliest opportunity to: Chief Engineer (MTRD)

Machakos Road, Industrial area, P.O Box 11873-00400 NAIROBI. | **Email:** chiefengineer@mtrd.go.ke | Website:www.mtrd.go.ke

Comparison of Wind Load Analysis on Low Rise Buildings by Using Different Design Codes

By Eng. Sum Kipyego and Caleb Chepsergon Kipruto

1. Introduction

WIND study is important to understand the possible damage, inconvenience or benefits which may result from wind interaction to the built environment (Cermak, 1975, p. 9). The resulting force that acts on buildings elevations as wind blows against the surfaces of the building, is called "wind load" (Cermak, 1975, p. 9). This load must be absorbed safely by the building's structure and transferred efficiently to the foundation of the building to avoid structural collapse. Investigation on numerous cases of building damages and even collapse show that, while many failures are undoubtably due to defects of workmanship, some cases of damage results from under-estimation of wind forces and that is frequently due to the lack of appreciation by designers on the significance of gust action and ultimately wind loading on buildings and more so on low rise buildings.

In structural design, buildings are under many kinds of loadings; ranging from dead load to live load. Besides these loads, wind load is also a critical loading that needs to be considered especially so for a low-rise building since most low-rise buildings are immersed within the aerodynamic roughness on the earth's surface where turbulent intensities are rather high (Smith et al., 2016). Low-rise buildings are less sensitive to wind loads compared to high-rise buildings that are subjected to wind loads of the same magnitude. Thus, designers are conservatively more concerned about vertical loads than the lateral loads when dealing with low and medium-rise buildings (Holmes et al., 2009). In doing so, these buildings are subjected to risk when extreme wind conditions impose large wind loads on the building.

The collating of five internationally recognized and used standards is important to understand the measure of sophistication achieved in addressing wind load by each standard and the underlying similarities in the parameters, equations and procedures described in each standard. Additionally, designers, researchers and engineering students will be able to know which country-specific factors and parameters originally designed for the native country of the standard can or cannot be directly adopted for use in Kenya for design purposes while using these standards. Furthermore, this research will highlight the performance of the provisions in the five standards on a low-rise building which will in turn help in the development of an international wind loading standard.

The Kenyan wind speed map that shows the basic wind speeds was developed in the 1970s and has never been updated since then (E. O Ong'ayo, S.K Mwea, 2014). Additionally, the wind speed map was based on thirty years of windspeed data collection resulting in the underestimation of wind speeds which in turn affects the wind loads subjected to buildings over their design life.

2. Methodology

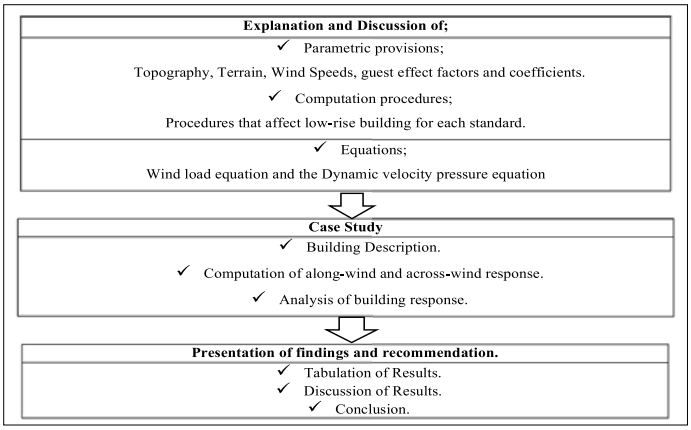


Fig. 1. Summary of methodology

a. Comparison of parameters

The provisions in the five standards uses different terminologies to describe similar parameters

Table 1. Parameter definition

Variable	Definition
P	Wind Pressure/ Load.
q, $q_{ref,}$ qh	Dynamic Velocity Pressure.
Cp, Cpe, Cpi, Cpf	Internal and External Pressure Coefficients.
Ce (Ze)	Exposure Coefficient
Ca	Shape factor
Cd, Cdyn	Dynamic Effect factor.
Cf	Force coefficient
Cfig	Aerodynamic Shape factor
Aref	The reference Area.

In wind load computation, the reference wind speed is the most important parameters. Across the five standards their provision is defined differently. For instance, BS 6399 uses mean hourly wind speed while ENV 1991-2-4 adopts a 10-minute mean speed-gusts as its reference wind velocity while CP3–4–2: 1972, ASCE 7-2005 and AS/NZS1170.2-2011 as summarized in table 2.

Table 2. Reference wind speed for the five standards.

Standard	Wind speed Definition	Reference Height	Recurrence Interval
CP3–4–2: 1972	3-second gust speed	10m above ground in an open ground.	Return period of 50 years.
BS6399–2:1997	Hourly mean wind speed	10 m over completely flat terrain.	Return period of 50 years.
ENV 1991-2-4:2005	10 minutes mean wind velocity	10 m above ground level in open country terrain.	Return period of 50 years.
ASCE 7-2005	3-second gust speed	10m above the ground in an open terrain	Return period of 50 years.
AS/NZS1170.2-2011	3-second gust wind	10m above ground level.	Return period of 50 years.

The topography factor accounts for wind speed-up over hills, ridges and escarpments and it is related to the reference wind speed at the base of these features. This factor has been provided only by the ENV 1991-2-4:2005, ASCE 7-2005, AS/NZS1170.2-2011 as showed in table 3.

Table 3. Topography factor

Standard	Roughness Category
CP3–4–2: 1972	None
BS6399–2:1997	None
ENV 1991-2-4:2005	$Ct = 1+2$ for $\Phi<0.3$; $Ct = 1$ for $\Phi<0.05$; $Ct = 1+0.6$ for $\Phi>0.3$. Where Φ is the upwind slope.
ASCE 7-2005	$Kzt = (1+K_1K_2K_3)^2$ Where $K_1K_2K_3$ are given.
AS/NZS1170.2-2011	$Mt = M_hM_{lee}(1+0.00015E)$ Where; M_h is the hill multiplier, M_{lee} is the lee effect multiplier, E is the site elevation above mean sea level

i. Internal and External Pressure Coefficients.

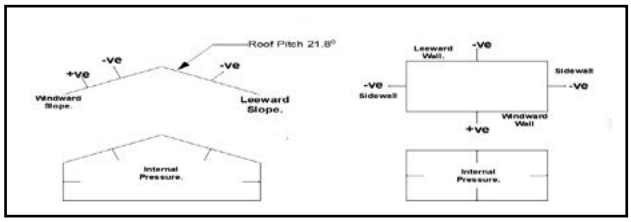


Fig. 2. Pressure coefficients for basic building shapes

The five standards give pressure coefficients for basic building shapes in the form of tables and graphs. They have adopted the same sign convention where; + (plus sign) means positive pressure acting towards the surface while – (minus sign) means negative pressure acting away from the surface as illustrated in the fig. 2.

ii. Terrain factor

The terrain factor modifies the basic wind speed to account for the variation of terrain and height. It also accounts for the variations of mean wind velocity due to its height above the ground level whereas the topography factor modifies the basic wind speed for sudden changes occurring in the topography such as increase of mean wind speed over isolated hills and escarpments.

Table 4. Terrain and roughness factor for the five standards.

Standard	Roughness Category
CP3–4–2: *1972*	Ground roughness 1 = *(open country no obstructions)* Ground roughness 2 = *(open country scattered windbreakers)* Ground roughness 3 = *(country with many windbreaks)* Ground roughness 4 = *(surface with large and frequent obstructions)*
BS6399–2:*1997*	Provides a table*(table4)* for sites in country and town terrain. Generally, the equation for computing the Sb is given as; Sb=Sc{1+(gt*St) +Sb} for country terrain. And Sb=ScTc{1+(gt*St*Tt) +Sb} for town terrain.
ENV 1991-2-4:*2005*	Terrain Category1 = *(open sea, lakes and smooth flat country without obstacles.)* Terrain Category 2 = *(farmland without boundary hedge, occasional small farm structures, houses or trees)* Terrain Category 3 = *(suburban or industrial area permanent forests)* Terrain Category 4 = *(urban areas in which at least 15% of the surface is covered with buildings, and their average heights exceed 15m)*
ASCE 7-*2005*	Roughness Category A – *large city centers.* Roughness Category B – *urban, suburban, wooded area or any terrain with numerous closely spaced obstructions)* Roughness Category C – *open terrain with scattered obstructions having height generally less than 9.1m* Roughness Category D – *flat, unobserved areas and water faces outside hurricane-prone regions*
AS/NZS1170.2-*2011*	Category 1 – *exposed open terrain with few or no obstructions and water surfaces at serviceability wind speed.* Category 2 – *water surfaces, open terrain, grassland with few, well-scattered obstructions having heights generally 1.5m to 10m.* Category 3 – *terrain with numerous closely spaced obstructions 3m to 5m high, suburban areas.* Category 4 – *terrain with numerous large high 10m to 30m and closely spaced obstructions, such as large city centers and well-developed industrial complexes.*

iii. Wind Load Computation Comparison

The five standards use different levels of approach to calculate wind load: simple procedure, standard method, detailed procedure, and wind tunnel tests. The scope of this research limited the study to the detailed, standards and simple procedure. Procedures that provide provisions to design for low-rise building were only considered and are presented in table 5 for each of the five standards.

Table 5. Wind load computation procedures for the five standards

STANDARD	PROCEDURE/ METHOD	EQUATION
CP3–4–2: 1972	Simple	P = q × Cp
BS6399–2:1997	Standard Method	P = q× Cp × Ca
	Directional method	P = q × Cp
ENV 1991-2-4:2005	Simple Procedure.	$P = q_{ref} \times Ce\,(Ze) \times Cp$
	Detailed Procedure.	$P = q_{ref} \times Cd \times Cf \times A_{ref}$
ASCE 7-2005	Special Low-Rise Method	P = qh [GCpf - GCpi]
	All Heights Method	P = qGCpe – qhGCpi
AS/NZS1170.2-2011	Standard Method	P = q × Cfig × Cdyn

iv. Dynamic Velocity

The dynamic velocity pressure for the five standards are described by the equations in table 6;

Table 6. Dynamic velocity pressure equation

Standard	Dynamic Velocity Equation.
CP3–4–2–3: *1972*	$q = 0.613\times(S_1S_2S_3\times Vref)^2$ Where, S_1 is the topography factor S_3 is the probability factor. S_2 is the ground roughness, building size and height factor. V_{ref} is the refence wind speed.
BS6399–2:*1997*	$q = 0.613\times S_b\times(S_a\times S_d\times Ss\times S_p\times Vref)^2$ Where, S_b is the terrain factor. S_a is the altitude factor. S_d is the directional factor. S_s is the seasonal factor. S_p is the seasonal factor. V_{ref} is the basic reference wind speed.
ENV 1991-2-4:*2005*	$q_{ref} = 0.625\times(C_r\times Ct\times C_{DIR}\times C_{TEM}\times C_{ALT}\times V_{ref})^2$ Where, C_r is the roughness coefficient. C_t is the topography coefficient. C_{DIR} is the directional factor. C_{TEM} is the seasonal temporary factor. C_{ALT} is the altitude factor. V_{ref} is the reference wind speed
ASCE 7-*2005*	$q_z = 0.613\times K_z\times Kzt\times K_d\times V^2$ Where, K_z is the velocity pressure exposure coefficient. K_{zt} is the topographic factor. K_d is the wind directional factor. V is the reference wind speed.
AS/NZS1170.2-*2011*	$q = 0.5\times1.2\times(M_d\times M_z\times M_s\times M_t\times V_R)^2$ Where, M_d is the directional multiplier. M_z is the terrain and height multiplier. M_s is the shielding multiplier. M_t is the topographic multiplier. V_R is the reference wind speed.

3. Results

This study was therefore aimed to compare the wind load analysis adopted by five standards in computing wind load. A quantitative comparison was also conducted by subjecting two building structures to a 45m/s three second wind guest with an annual probability of 0.02 and comparing the along-wind and across-wind responses.

Given that other standards use the mean hourly and 10-minute mean speed gusts for their reference wind velocities the 45m/s, 3-second gust wind speed had to be adjusted for gust duration to the appropriate reference velocities.

For BS6399 the 3-second gust wind speed was converted in to mean hourly wind speed using the method proposed by (Nicholas J. Cook, 1999). According to Cook's method, the mean hourly wind speed (Vmean)can be calculated from gust wind speed (VG) as shown in the equation below.

$$Vmean = VG/Sb \qquad \textbf{Equation 1}$$

Where, Sb – is the terrain and building factor at 10 m height in open terrain as given in Table 4 of BS6399-2:1997. A value of 1.62 was used for the portal frame warehouse and 1.85 for the 10-storey building.

For ENV 1991-2-4 the mean hourly wind speed was then converted into 10 minutes average wind speed by using factor 1.06 as proposed by the Institute of Civil Engineers in United Kingdom (ICEUK). For the remaining three standards the 45 m/s gust wind speed was directly adopted.

Table 7. *Wind speeds for the different averaging times*

Wind Speeds(m/s).	Portal frame warehouse	Ten story building
CP3–4–2–3: *1972*	45	45
BS6399–2:*1997*	28	24
ENV 1991-2-4:*2005*	29	25
ASCE *7-2005*	45	45
AS/NZS1170.2-*2011*	45	45

Wind load calculation for both buildings is given in the appendices. In this section values of importance have been selected for discussion purposes illustrating wind load in the along-wind and across-wind directions.

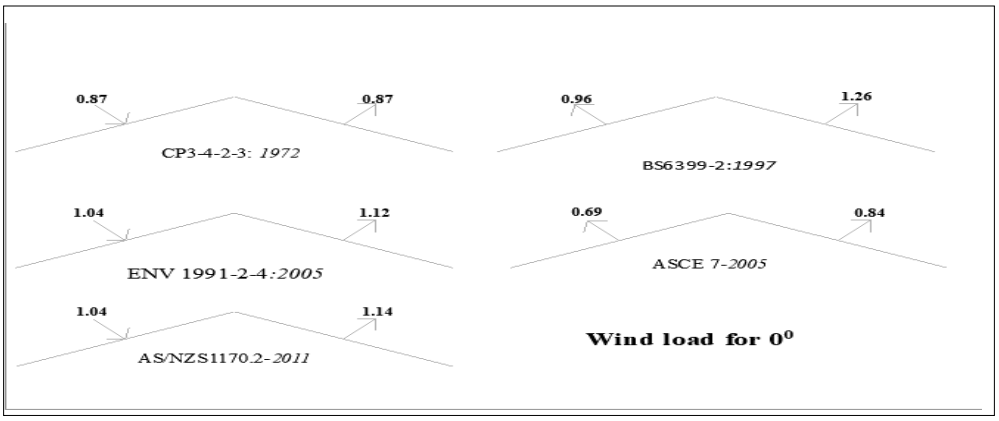


Figure 3. *Extreme wind load on portal roof.*

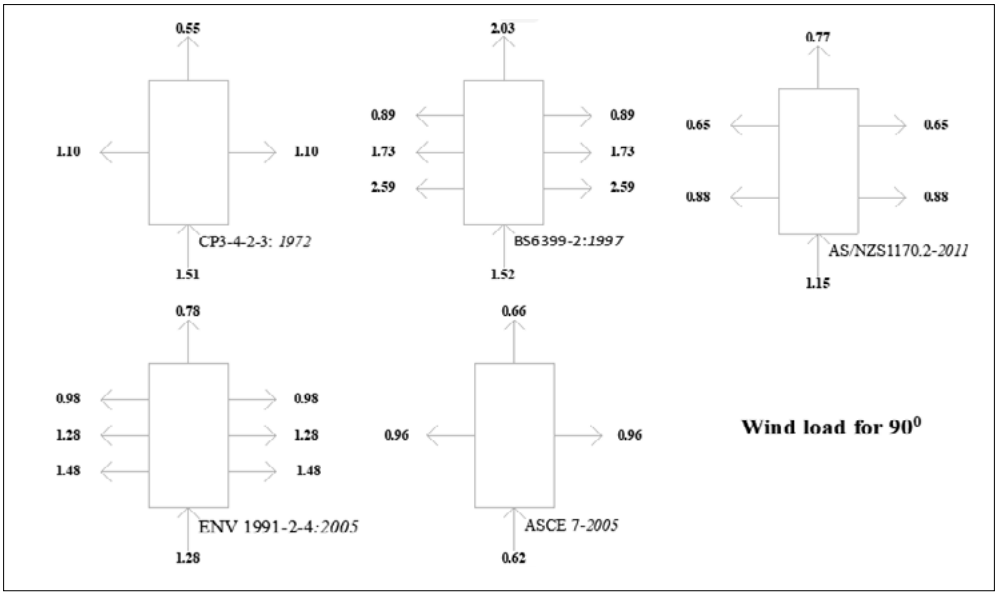


Figure 4. *Extreme wind load on ten story building.*

4. Discussion

The basic premise is that wind loading phenomena is invariant and wind loads derived for a given reference wind speed should be the same across all the wind load standards. Across the five standards it was clear that wind load equation followed a model of some sort where wind load was equal to the product of the dynamic velocity pressure and the aerodynamic coefficients where the dynamic velocity pressure accounted for factors of the wind speeds that have been modified by the topography, terrain and altitude whereas the aerodynamic pressure accounted for the building characteristics; shape, size and number of openings, guest effect factors internal and exposure factors as summarized in table 5.

Wind load =Dynamic Pressure(q) × Coefficients(C).

$$P = q \times C \qquad \textbf{Equation 2}$$

Total pressure mainly depends on three factors namely, the wind speed, external and internal pressure coefficients. The five standards adopted reference wind speeds with different averaging time with recurrence interval of 50years. Across the five standards it is clear that the reference wind speed is dependent on terrain roughness and height above ground. The five standards use reference wind speeds that are related to a height of 10 meters above the ground. The different definition of the reference wind speed accounts for significant differences in the wind load. Conversion of these wind speeds to respective dynamic velocity pressure by terrain and topographic coefficients also leads to differences in the final wind load.

External and internal pressure coefficients are different from one code to another due to their different methods and strategies of determination of these coefficients in relation to their existing climatic conditions. A quantitative comparison has been presented in table 10 for both building. Since most of the parameters had been normalized in the case study and variation does appear to be large, the only reasonable explanation would be that different standards have adopted different wind tunnel test results on which the coefficients have been based.

Other coefficients include the internal and external pressures, exposure factor, shape factor or aerodynamic factor, guest effect factors and the dynamic response of the building. These factors are specific to individual standard according to the prevailing conditions in the native country and the different strategies adopted in determination of these coefficients. The ASCE and AS/NWZ both specified for an importance factor while the other three standards are silent in this regard. A unique importance factor is associated with buildings or structures of a certain category.

For the case study to check for correlation of the wind loading standards coefficient of variation was computed for the extreme wind load cases that were presented in figure 4.1 and figure 4.2. It was evident that for the portal frame structure the coefficient of variation of total wind load ranges from 15% to 18% while for the ten-story building the coefficient of variation of total wind load ranged from 30% to 64%. It is also clear that as the height of the building increases, the coefficient of variation also increases with the highest range being in the leeward wind direction of the ten-story building.

5. Conclusion

This research examined the differences and similarities in wind load analysis on a low-rise building of five major international wind standards. The aim was not only to identify the role of various parameters that contribute to variations in the overall analysis but also compare the induced loads on two structures in the along-wind and across-wind directions. The findings of this research were in broad agreement with the results from other research. The following conclusions were therefore deduced.

1. The varying definitions of wind characteristics including mean wind velocity profiles, gust effects and wind correlation coefficients are the primary contributors to the variations in the predicted wind load.
2. Parameters associated with the wind velocity characteristics contribute the most towards apparent differences in the resulting wind responses in both the along-wind and across-wind.
3. (BS6399-2:1997) predicts a higher loading in the leeward direction for the portal frame warehouse greater than 20% compared to the other standards and 85% in for the ten-story building sidewall while (ENV1991-2-4_2005) gives a higher loading for portal frame warehouse in the windward direction greater than 13% compared to the other standards.

Authors
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Email: sumurei@gmail.com

Engineers, Business Networks and the Black-Tie Protocol

IEK President, Eng Nathaniel Matalanga (fourth right), with Council member, Eng Grace Kagondu (right), and other attendees during the President's dinner.

By Eng. Catherine Nyambala

IT is said that etiquette can have a big effect on your social standing, make or break business deals or even influence diplomatic decisions. Last December, the IEK President's appreciation dinner was themed "Black Tie".

Black-tie dress code does a gentleman a favour. It's simple and specific: Black tuxedo or suit, black tie or bow tie and white shirt with wing collars. For women it simply means a long timeless gown. The black and white "monochromatic" uniformity among the men lends events an air of sophistication.

As a matter of fact, there is a reason why James Bond always appears in a tuxedo at least once during a movie. Black tie sends a message of elegance and quiet confidence. This is what Engineers exude (or should be exuding) every day at the workplace, and why should they not exude it at a dinner?

The term tuxedo originated in the USA in 1888, it was named after Tuxedo Park, a Hudson Valley enclave for New York's social elite. Elite means a select group that is superior to the rest of a group or society in terms of ability or qualities; the richest, most powerful, best educated, or best trained group in a society. Whichever standard you use, Engineers are elite. Thus, if they choose to, they are well placed to be socially elite. Engineers have worked as hard or even harder than the next person and therefore they are deserving. They deserve the finer things in life; for example, wearing a tuxedo or enjoying a black-tie event.

The President's dinner is not just about enjoyment and eating delicious food, more importantly, it is about social and business conversation, pleasant ambiance, and relaxation. It is an opportunity to network and exchange knowledge and you want to focus on that (not appear to breach the protocol). In international events where international protocols and business etiquette apply, when you are in breach of the protocol, it could interfere with your ability to forge networks.

It may well be possible that wearing a tuxedo is symbolic of one's potential to have a high profile, placing one at a more advantageous position with regard to the possibility of high-level opportunities. For the purposes of this article, the tux is a visible symbol of commitment to an agreed theme. It represents one's capacity to adhere to a certain agreed standard, which is very important, in business and more so in Engineering. Therefore, in conclusion, it may be beneficial to respect any proposed theme in future, particularly, in international events. Oh, and one last thing every man should have at least one tuxedo in his closet and every lady at least one red carpet gown. Enjoy your next black-tie event.

Eng Nathaniel Matalanga with his daughter.

Eng Carren Oyola, GE Abdifatah Jama and Konza Chief Eng Anthony Sang.

Other guests pose for a photo on the sidelines of the dinner held at Serena Hotel, Nairobi, on December 21,2021.

Students' voices

How Kenya's roads and housing have grown

Over the years there has been tremendous growth in what started as the Ministry of Works and is now the Ministry of Transport and Infrastructure. Today, the ministry comprises five State departments of Infrastructure, Transport, Public Works, Maritime and Shipping Affairs, and Housing and Urban Development.

Part of the ministry's achievements so far is the creation of crucial road corridors that connect Kenya to its neighbours, such as the northern and central corridors. This has been facilitated by the East African Community through the formation of roads boards, roads agencies, the private sector, axle load control regulations and harmonisation of regional policies.

The collaboration between the Kenyan and Chinese governments and other local contractors has seen paved and unpaved roads grow from 63,000km in 2003 to 166,000km currently. Tarmacked roads have grown from 8,300km to 17,600km within the same period, according to a survey by the Kenya Roads Boards (KRB).

The housing sector has also recorded notable growth in housing infrastructure in the last 20 years, with the ministry embarking on its affordable housing programme and Kenyans getting more friendly residential facilities.

The first municipal public housing in 1928 at Kariokor was a Landhie concept for non-Europeans in Nairobi. The housing facilities consisted of bachelor barracks ordered according to a strict grid. They had outdoor washing and cooking areas and space for flower and kitchen gardens. Others were located in Muthurwa, Pangani and Pumwani with different setups.

The Garden City concept came to replace the Landhie concepts. It was first actualised in Shauri Moyo in 1930s onwards but fully realised in Ziwani, Starehe and Kaloleni by 1948. They were designed for European government workers but some were used by African workers. Today the government has re-embarked in improvement of these estates and creation of more modern, habitable and accommodating housing facilities.

Dennis Njenga, BSc Civil Engineering Student, JKUAT

How ready are we as a country to embrace the Euro-codes in our designs?

The Eurocodes define the approved standards that a structural design should obey within the European Union states. Adopting these standards in Kenya is critical for continued partnership with this body. Not once I felt frustrated whenever I tried to engage senior structural engineers on Eurocode designs during my attachment. I observed rigidity in our design criteria done by inflexible expertise. Keeping the design philosophies constant, the use of imported design parameters to a given local design is expensive in terms of money and time. Given the chance to avoid this, can we grab it?

We have always relied heavily on the British standards for our designs. However, confusion has always been a risk involved as a result of a series of amendments to the codes. The UK has then moved to embrace the Eurocodes to pacify these conflicts. The standards of design in the Eurocodes leave an open design space to be explored by the designer, contingent to the design parameters as established in a country's National Annex. How close is Kenya to obtaining the basic National Annex?

Where are our wind map and a comprehensive national geotechnical data? Undoubtedly, only vigilance and embrace of Eurocodes will eliminate engineering disasters in Kenya. We should start by capacitating trainers in higher institutions to be legible of Eurocodes. This would trickle down to trainees as with Eurocodes, we are 'Building the Future'.

Hillary Odwuor Odedo is a 5th year Engineering Student at Masinde Muliro University of Science and Technology.

IEK MEMBERSHIP REPORT

The IEK membership committee meets every month to consider applications for membership of the various classes received at the secretariat. The IEK council at its 486th and 487th council accepted the following members under various membership categories as shown below;

MEMBERSHIP CLASS	NUMBER ACCEPTED- 486TH COUNCIL	NUMBER ACCEPTED- 487TH COUNCIL
FELLOW	2	-
CORPORATE	29	24
GRADUATE	141	75
GRADUATE ENGINEERING TECHNICIAN	3	-
GRADUATE ENGINEERING TECHNOLOGIST	10	2
STUDENT	1	1
TOTAL	**186**	**102**

During the period we had 2 members who transferred from the class of Corporate to Fellow member and 53 who transferred from Graduate to Corporate member. In addition we had 216 graduates, 3 graduate engineering technicians, 12 graduate engineering technologists and 2 students accepted as members.

Gender Data

Gender	No.	Percentage
Male	240	83.3%
Female	48	16.7%
TOTAL	**288**	**100%**

486TH APPROVAL

	FELLOW	
NO	**NAME**	**REG. NO**
1	Justus Aufridus Otwani	F.2743
2	Evelyn Susan Njambi Ombuya	F.3919

	CORPORATE	
NO	**NAME**	**MEMBER NUMBER**
1	Samuel Njau Njugi	M.5993
2	Collins Ogutu Miruka	M.2013
3	Korir Kiplangat Stephen	M.4260
4	Ontweka Zablon Zachariah	M.4019
5	Arphaxad Mwangi Githui	M.6915
6	Isaac Nyingi Thiong'o	M.7555
7	Anthony Karume Kinuthia	M.1684
8	William Kyalo Muthoka	M.6979
9	Magdalene Njoki Lutta	M.7559
10	Jeremiah Nzioki Mwangangi	M.4083
11	Morris Kinyanjui Kamau	M.3759
12	Chris Kipngetich Tembur	M.8946
13	Enos Alolo Nyagwande	M.8076
14	Wilson Kipruto Maritim	M.4686
15	Fredrick Wagude Ogano	M.7049
16	Daniel Muchoki Njima	M.8469
17	Aldina Muthoni Mugo	M.8181
18	George Achola Opado	M.8472
19	Ronald Oluoch Okello	M.7483
20	Boniface Kipkemei Amdany	M.7360
21	Rodgers Omondi Ayiemba	M.7660
22	Kennedy Otieno Omondi	M.5162
23	George Oscar Odongo Dawo	M.6196
24	Joram Juma Kennedy	M.7199
25	James Gitari Kiura	M.9144
26	Edgar Kipkurui Mutai	M.5373
27	Peter Tipis Mpusia	M.3160
28	Edgar Mwangi Kaniu	M.8273
29	Lilian Buchehe Mukoya	M.7462

487th APPROVAL

	CORPORATE	
NO	**NAME**	**MEMBER NUMBER**
1	Audrey Adhiambo Obwanda	M.7339
2	Cliff Nyangoto Machuka	M.6810
3	Daniel Owino Kotieno	M.8461
4	Dennis Muhadi Busolo	M.7330
5	Edmond Wanyela Wekesa	M.7536
6	Edward Karani Njeru	M.6639
7	Edward O. V. Odhong	M.4467
8	Eldridge C. Mulongo Kisiang'ani	M.8539
9	Elijah Osuga Nyamaiyeria	M.7275
10	Ian Mwenda Mugambi	M.6320
11	Edwin Agoi Kisame	M.8274
12	Jeremiah Nzioka Kivuva	M.7363
13	Joseph Mumo Muange	M.7039
14	Micheal Elton Otieno Mululu	M.6828
15	Mwangi Irungu Mwangi	M.8486
16	Proson Kipngeno	M.4390
17	Felix Itapara Ochieng	M.8624
18	John Ndinyo Mukebi	M.8440
19	Nelson Mag'eni	M.7946
20	Mercy Koros	M.10748
21	Dennis Onyango	M.7598
22	Eric Gituma Gitonga	M.8255
23	Martin Kirigwi Wokabi	M.6268
24	Nyabeta Ronald Kenyansa	M.8090

The council invites Engineers and affiliate firms to apply for membership in the various membership classes, kindly follow the link **Membership Classes (iekenya.org)** for a list of classes available.

Graduate and Corporate members are encouraged to apply for transfer of class to Corporate and Fellow class respectively. Members can check eligibility and how to apply on our website using the following link: **https://iekenya.org/web/register_as_member**

The IEK condoles with family and friends of our members who have passed away in the recent past. May their souls rest in peace.

"Death is not extinguishing the light . It is putting out the lamp because the dawn has come."

REPUBLIC OF KENYA

ENGINEERS BOARD OF KENYA

ENGINEERS BOARD OF KENYA

THE ENGINEERS STAMPS

Introduction/ Background

Pursuant to Part II, Rule 10 (4-8) of the Engineers Rules, 2019 the Board procured the Engineers Stamp. It states that "the Board shall, issue an official rubber stamp to every professional and consulting engineer registered under the Act on payment of the fees prescribed in the Third Schedule of the Rules. In addition, the rubber stamp issued shall be used for approving or certifying engineering documents including design calculations, drawings, technical reports, and other engineering documents. A professional engineer or a consulting engineer shall sign and date and affix the rubber stamp issued under paragraph (4) on any approval or certification given by the professional engineer or a consulting engineer.

Furthermore, in fulfilment of Section 7 (1) (m) of the Engineers Act, 2011, that mandates the Board to "set standards for engineers in management, marketing, professional ethics, environmental issues, safety, legal matters or any other relevant field" the Board developed Guidelines for use of the Engineers Stamp.

Purpose of Engineer's Stamp

To identify and distinguish all work prepared by a professional engineer, or under his/her direct supervision

- By affixing the stamp, the professional engineer assumes responsibility and is answerable for the quality of work presented. Signing and stamping of an engineering document by a professional engineer certifies that the professional engineering services rendered have been completely, adequately and/or reliably performed.
- Proper use of the stamp is essential, not only for complying with the Engineers Act, 2011 and the Engineers Rules 2019, but also for assuming the public that the stamp represents the profession's commitment to the set standards.

Importance of Engineer's stamp

- It gives assurance that the work meets the standards of professionalism expected of a professional engineer.
- By affixing the stamp, professional engineers assume full responsibility for their judgments and decisions based on their knowledge, skills and ethical conduct.
- It is a statement by a professional engineer to the intended recipient of the engineering document that he/she can rely upon the contents of the engineering document.

Features of the Stamp

- Self-inking with built-in internal stamp pad;
- Protective cover on the base;
- High quality rubber;
- EBK Logo affixed on the casing;
- The name and registration No. of the engineer on the stamp printout; and
- Unique security features

To apply, Kindly, pay Kshs. 5000 to Mpesa Paybill: 839300; Account Number: Your Reg. No

From left: Eng. Margaret Ogai, Registrar EBK; , Prof. Arch. Paul M. Maringa (PhD), Corp, Arch, (Maak), Mkip, the Principal Secretary for the State Department of Infrastructure; and Eng. Erastus Mwongera FIEK, RCE, MBS during the launch of the Engineers'stamp at KICC

The Board Launched the Engineers' Stamp on 9th December 2021 at Kenyatta International Convention Centre graced by the Principal Secretary for the State Department of Infrastructure, Prof. Arch. Paul M. Maringa (PhD), Corp, Arch, (Maak), Mkip.

The issuance of the Engineers' stamp has officially commenced. The Board, through the Registrar, Eng. Margaret Ogai issued the 1st stamp to Eng. Christopher Atsyaya on 7th February 2022

JOIN US IN CELEBRATING THE

WORLD ENGINEERING DAY FOR SUSTAINABLE DEVELOPMENT

4th March, 2022

BUILD BACK WISER ENGINEERING THE FUTURE

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