



NBRRI

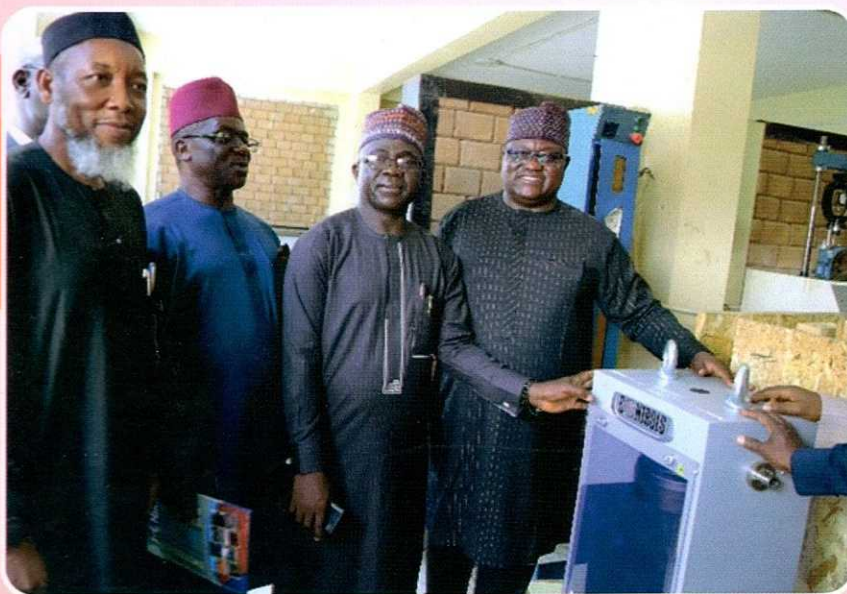
NEWSLETTER

Vol: 16 No 3, July - September 2023 3rd Quarter Edition

**NEW MINISTER
OF INNOVATION,
SCIENCE AND
TECHNOLOGY
APPOINTED**



CHIEF UCHE GEOFFREY NNAJI
HONOURABLE MINISTER
FEDERAL MINISTRY OF INNOVATION, SCIENCE AND TECHNOLOGY



**NBRRI DONATES ENGINEERING LABORATORY
EQUIPMENT TO SIX FEDERAL UNIVERSITIES**

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NBRRI

*(Vision, Mission & Core Values)
Building capacity and setting the
pace in indigenous construction
technology development.*

VISION

To evolve and use a comprehensive and integrated approach in capacity building and investment promotion so as to foster the application of environment friendly and energy efficient innovation, construction materials, manufacturing technologies and cost effective building and road construction practices, which will enhance job creation, wealth generation and poverty reduction as well as nurture the emergence of vibrant, knowledge based and highly competitive indigenous construction companies capable of meeting global standards.

MISSION

Integrate R & B, Capacity building and robust extension services in which technology innovation and knowledge based practices in the fields of building road and engineering materials will be used to provide adequate and affordable housing and road infrastructure as well as increased economic empowerment.

CORE VALUES

- Professionalism
- Resourcefulness
- Commitment and Integrity
- Innovativeness

Editorial

I welcome you all to the 3rd quarter of the 2023 Newsletter. We have stories that will confirm that NBRRI has accomplished a lot in the months under review despite all challenges and disappointments.

In this edition, PAVION Group of Company, Brazil paid a courtesy visit to the Institute seeking for collaboration with NBRRI; the National Executives of NICE also Visited NBRRI to strengthen the existing bonds between both organizations. NBTI is also set to partner with NBRRI for the promotion of Local Contents in the Country during the period under review.

Also featured in this edition are the various ways in which NBRRI broke grounds with constituency projects for community development in Gindin Dorowa community in Wukari Local Government Area of Taraba State. NBRRI is also contributing to the building of a better future for generations to come via Educational Infrastructure by commissioning a block of three (3) classrooms at WAJAH Girls Primary School in Hong Local Government Area of Adamawa State.

On a bigger ground, NBRRI has positioned itself in educational advancements in the country as it donated Engineering Laboratory Equipment to Six Federal Universities in Nigeria. The DG/CEO also commissioned and handed over a block of 3 classrooms and boreholes at Community Primary School, Larbarfido and Government Day School, Lakurum respectively all in Billiri Local Government Area of Gombe State.

The National Association of Nigerian Students Honoured Engr. Prof. Samson Duna with the Highest-Ranking Award from the Association as the "Grand Commander of Nigerian Students". NBRRI also Received an Excellent Performance Award from Bureau of Public Service Reforms. The Head, Engineering Materials Research Department (EMRD) of the Nigerian Building and Road Research Institute also received accolades from the National Association of Nigerian Students.

Also included in this edition is a paper presented at the Annual General Meeting of the Nigerian Institute of Building tagged 'TIN CITY 2023' by Engr Professor Danladi Slim MATAWAL, B.Eng. (ABU), M.Sc. (London), DIC, Ph.D. FANSE, FAEng., FAEEA, FNSE, FNICE, FNIGE, FNIHTE, FNAEGE, FNIPE (Distinguished Professor of Civil Engineering) Interim President, Academy of Natural Science and Engineering in Nigeria (ANSEN) titled 'Cement and Concrete: Advances in Research and Applications'.

There are pictures from all these various events and trainings conducted by NBRRI to keep you informed, entertained and educated.
Cheers!

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UCHE NANJI IS THE NEW MINISTER OF INNOVATION, SCIENCE & TECHNOLOGY



President Bola Ahmed Tinubu has appointed Chief Uche Nnaji from Enugu State as the new Minister of

Innovation, Science & Technology. A business man and Politician, Chief Nnaji was born in Akpugo Nkanu West LGA in Enugu State into the family of Chief & Mrs. Obed Nnaji. He is the first of four children.

Uche had all of his education in Enugu state, his home state. He attended Santa Maria Primary School in Enugu (now Ziks Avenue Primary School); St. Patrick's College in Emene, Enugu, and the University of Nigeria's Nsukka Campus,

Business career

Uche's early exposure to the business world greatly benefited from his mother's enduring value for resource management with integrity and hardwork – traits which became manifest during his service as a Youth Corper at NASCO and Jos International Brewery, all in Plateau State.

Both organisations expanded his outlook and further equipped him with good business practices and general procurement skills.

Political career

Chief Nnaji came to the limelight in 1999 when he won the senatorial ticket of the then Alliance for Democracy, AD.

According to reports, Nnaji was going to

run for senator in the PDP's Enugu East Senatorial Zone, but the party's then-National Secretary, Dr. Okwesilieze Nwodo, changed his name to Senator Ken Nnamani after he switched from the APP.

he switched to the Alliance for Democracy (AD) 72 hours before the election and defeated PDP candidate Senator Ken Nnamani in 65 out of 66 wards.

He was later to step down for Chief Jim Nwobodo, who was eventually elected senator for the senatorial district.

Nnoli is the candidate of the Peoples Democratic Party for the House of Representatives in the 2023 general elections. He was re-elected.

Some of Chief Uche Nnaji's accomplishments in politics include:

- Won election as Senator, Enugu East Senatorial Zone 1999 (unconditionally relinquished the seat to HE Chief Jim Nwobodo).
- Foundation Member–PDP South East Zone, 1998.
- Convener–PDP Enugu State, 1998.
- Caucus Member- PDP Enugu State, 1998.
- Member–PDP National Finance Committee & Poverty Alleviation, 1998.

He also served in the following public positions:

- Member–Board of Directors Federal Capital Development Authority [FCDA].
- Chairman–Finance and General Purpose Committee FCDA.
- Member–Establishment Committee FCDA.

Chief Uche is married with four children.

NEW MINISTER SAYS I, S & T IS A GREAT ROADMAP FOR ECONOMIC TRANSFORMATION OF NIGERIA



The new Minister of Innovation, Science and Technology, (FMIST) Chief Uche Nnaji has said that FMIST is a Ministry poised to guide Nigeria into the knowledge-based new world Economy with its foundation rooted in knowledge, Innovation, Science and Technology.

The Minister stated this while addressing the members of the management and Staff of the Ministry at the official Handover Note ceremony by the Permanent Secretary today, in Abuja.

In his address titled "New Approach and Expectations for the Ministry of Innovation, Science and Technology" meant to transform the fortunes of this great Country through critical activities of the Ministry and its affiliated agencies.

Nnaji called for stronger collaboration between the Ministry and its agencies which, according to him, will enhance unity, through effective communication and performance.

He urged the Managements and staff of the Ministry and its Agencies to work hard, for result oriented contributions to the prosperity of our great nation.

Earlier, the Permanent Secretary of the Ministry, James Sule welcomed the Honourable Minister to the Ministry on behalf of the staff and Management.

He described him as a philanthropic man that is ready to offer his wealth of experience to the Ministry, by synergizing with all the stakeholders in the sector in order to achieve the mandate set by Mr. President.

He also presented a Handover Note of the Ministry to the Honourable Minister so as to enable him know and understand the activities, achievements and challenges of the past administration.

PAVION GROUP OF COMPANY READY FOR COLLABORATION



A team from PAVION GROUP OF COMPANY Limited, Brazil paid a visit to the Nigerian Building and Road Research Institute's Headquarters in Abuja on 5th of July, 2023.

In his opening address, the Director-General of NBRRI Engr. Prof. Samson Duna spoke on the mandate, vision and purpose of NBRRI in Nigeria. He also explained the various research and service departments and their functions in the institute. He concluded by hoping that the prospect of the collaboration with PAVION GROUP will lead to having a common interest and comparison on the NANO Technology which the institute has been involved in which will also be a

means of adding value to the country's road and housing sector.

The PAVION Director Jiro Del Oliviera, spoke about the reason for the partnership in which he listed few reasons which arose due to the good work NBRRI has been doing in Nigeria. He explained further that the group wants



to partner with NBRRI so as to promote development, build the best foundation available by using NANO Technology which he says will help in time saving and manage resources.

The brief meeting ended with the director of PAVION GROUP and his team been led on a tour of NIBRRI laboratories and explanations of the machines.

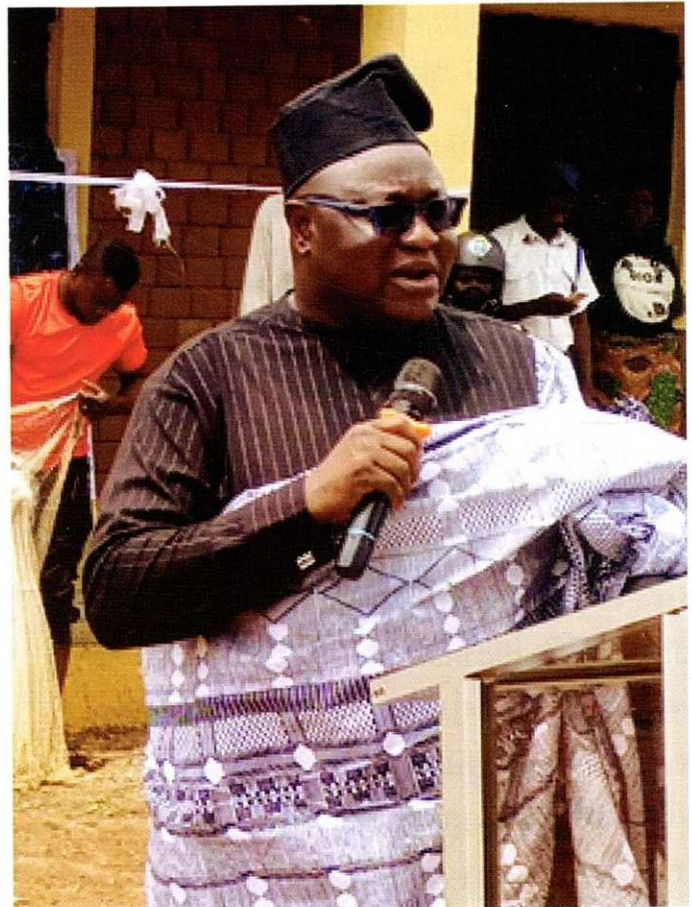
NBRRI BREAK GOUNDS IN TARABA STATE WITH CONSTITUENCY PROJECT FOR COMMUNITY DEVELOPMENT



demonstration of NBRRI technologies in the area of research to find out how these materials react to different environments. Noting that, the technology is weather friendly as it has the tendency to regulate itself to soothing room temperatures in all seasons.

History was made in the North Eastern part of Nigeria when the people of Gindin Dorowa community in Wukari Local government area of Taraba state turned out en masse on Saturday 8th July, 2023 to witness the commissioning and handover ceremony of a block of 3 classrooms to the authorities of the state. The infrastructure which is located at the Government Day Secondary School Dorowa is the first of its kind in the state.

Duna said, the NBRRI technology is currently being used across Nigeria to construct user friendly and cost-effective



Speaking passionately on the need to explore Nigeria's locally sourced technologies for developmental growth, the Director-General and Chief Executive Officer of the Nigerian Building and Road Research Institute (NBRRI), Engr. Prof. Samson Duna said, one of the interests of the Institute is the

structures in form of skills acquisition centres, schools, markets and so on.

He enjoined Nigerian lawmakers to patronize the NBRRI technology to build structures for their constituencies as the Institute is always ready with an array of professionals both in building and road construction. He promised that NBRRI will be available for more partnerships with the state via constituency interventions as well as Individual ventures. As he noted that the project being commissioned was the brain child of a member of the community, Ms. Jennifer Jummai Anagu.



Before handing over the NBRRI built collaborative structure to the community, Prof. Duna enjoined the authorities to imbibe a proper maintenance culture for future use.

In his speech after due observations, the Executive Governor of Taraba State, His Excellency, Dr. Agbu Kefas lauded the initiative stressing that, his administration had earlier declared a state of emergency on education in the state due to the deplorable nature of the schools. Adding that, "No responsible government can toy with the Education of her people and expect progress"



Speaking further, he said "My plan regarding human capacity development by the special grace of God is education. Because this is the key area capable of transforming the fortunes and profile of our dear state. I'm indeed determined to transform our educational sector to an enviable standard not only in the North-East subregion but the

country at large, God's willing. The honour done to my state today by NBRRI is not far from my dream kind of schools" His Excellency was ably represented by Honourable Josiah Yaro Angye, member representing Wukari II at the Taraba state House of Assembly and the Chairman of the committee on Education.



Present at the event were the Chairman, Nwunyu Development Association Mr. Siman Emmanuel Angyu, who gave the welcome address, His Royal Highness, Manu Bala Gani, Chief of Matar-fada Chiefdom, the Permanent Secretaries from the Ministries of Education and Works, Education Secretary, respectively.

Meanwhile, as a sign of appreciation and honour, the DG/CEO of NBRRI was beautifully adorned in the Jukun traditional attire known as "Kyadzwe" by the Chiefdom.

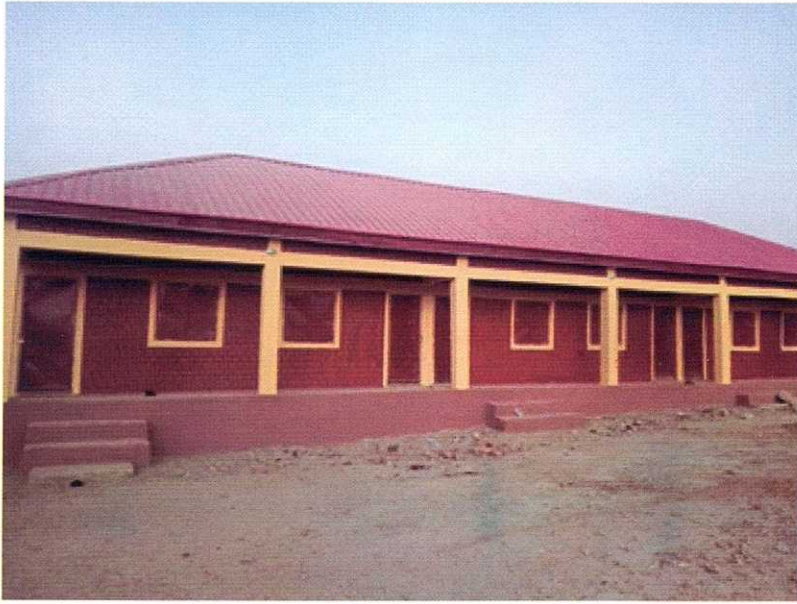
Traditional dance groups were also on ground to showcase the diverse and beautiful dance steps of the Jukun heritage.

Also, in his capacity as the National President of the Boys Brigade of



Nigeria, Prof. Duna was duly recognized and given the honourary guard of honours by the Battalion Council, Gindin Dorowa command.

NBRRI: BUILDING BETTER AND FUTURE GENERATIONS VIA EDUCATIONAL INFRASTRUCTURE



Salihu Mustapha, the immediate past Director-General of NBRRI Prof. Danladi Slim Matawal and the current DG/CEO of NBRRI Prof. Samson Duna.

Prof. Salihu Mustapha in his speech appreciated the entire NBRRI for their immense contributions in

the society as he also thanked the contractor for quality job delivery.

The importance of conducive learning environment cannot be over emphasis, as it enhances learning activities in many ways. Again, the Nigerian Building and Road Research Institute (NBRRI) on 19th July, 2023 commissioned a block of three (3) classrooms at WAJAH Girls Primary School in Hong Local Government Area of Adamawa State.



The project which was initiated by Prof Mustapha Salihu serves as a binding force in a lasting relationship between three (3) renowned Professors; former Vice Chancellor (VC) Federal University of Technology, Yola (FUTY) Prof.

Just like Oliver Twist, he requested for more intervention by NBRRI for his community in future. Speaking about Prof. Matawal, Prof. Mustapha emphatically

explained that Prof. Matawal is a great visionary leader for his positive role he has played and still in NBRRI by making sure that NBRRI is taken to a greater height.

Mr. Mohammed Abubakar the Educational Secretary (ES) of Hong Local Government expressed a profound gratitude to Prof. Duna for the construction of the block of classroom that added beauty to the environment and a great educational input to the future of young generations within the community.

Prof. Duna before commissioning the structure called on all stakeholders to adopt maintenance culture which he explained that by so doing, they will attract more intervention by NBRRI.

In appreciation, the Headmistress of the school, Mrs. Mary Dawar in her vote of thanks requested the local government chairman to provide security for the school.

The event was also graced by some

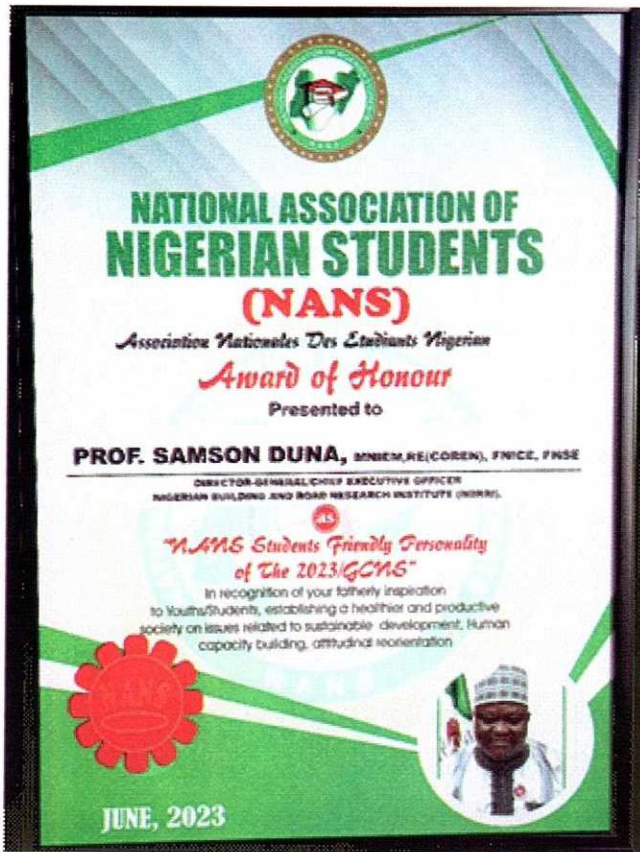
notable political elites in Hong such as the local government chairman Hon. Usman Inuwa who also in his speech



stated that he is amazed for such donation of structure to his community and prayed for the donors and the entire NBRRI.

Finally, the commission and hand over of keys of the classrooms was done with the high point of the event been the entertainment of guests by a display of special cultural dance by natives of Hong (Kilba).

NANS BESTOWS HIGHEST AWARD ON PROF. DUNA



Association of Nigerian Students (NANS) who paid a courtesy visit to the Nigerian Building and Road Research Institute (NBRRI) on Monday 24th July, 2023 on a remarkable honour and conferment on the DG/CEO the highest and prestigious honour as the "Grand Commander of Nigerian Students".

While delivering their speech before the presentation of the certificate and medal to the DG, the leader/representative of the National President of NANS, Comrade Adamu AdamuBatazu briefed the house on the purpose of their visit which is the conferment of the great honour as

Praises being sung before a good leader speaks positively on his personality even in his/her absence. Speaking on the personality of Engr. Prof. Samson Duna, the amiable and dynamic Director-General/CEO of the Nigerian Building and Road Research Institute, one can liken his personality to that of a great and distinguished nation builder, beloved father to the youth/students, visionary, and an outstanding hero. All these were part of what motivated the National Executives of the National



"Grand Commander of Nigerian Students" (GCNS) on Prof. Samson Duna. In collaboration with Comrade Usman Tankiya, a member of the NANS executives, both great students



during their speeches thanked the DG on behalf of the National body of the Nigerian Students for his fatherly assistance and contributions towards a successful academic growth. They also acknowledged the great works of Prof. Duna which made him to be

the 5th personality in the entire country to merit this great honour.

In response, Prof. Duna expressed his gratitude for the honour and great recognition accorded him by the students. He further, explained how he was connected to different institutions and his top most priority being improved academic growth in the country. He further briefed the visitors on some of NBRRI's R&Ds, how research takes place, building collapse as well as educational contributions the institute has made and still making towards the growth of education in the country. He mentioned the numerous engineering equipment NBRRI has donated to selected tertiary institutions and are still willing to do more across the six geopolitical zones in the country.



In conclusion, the DG stated that due to his quest for educational growth and capacity building in students, he has made it a thing of mandate that NBRRI will never reject students as they come for their various industrial trainings and NYSC programmes, as students are his primary constituency.

NBRRI EMR DEPARTMENT HEAD, RECEIVES ACCOLADE

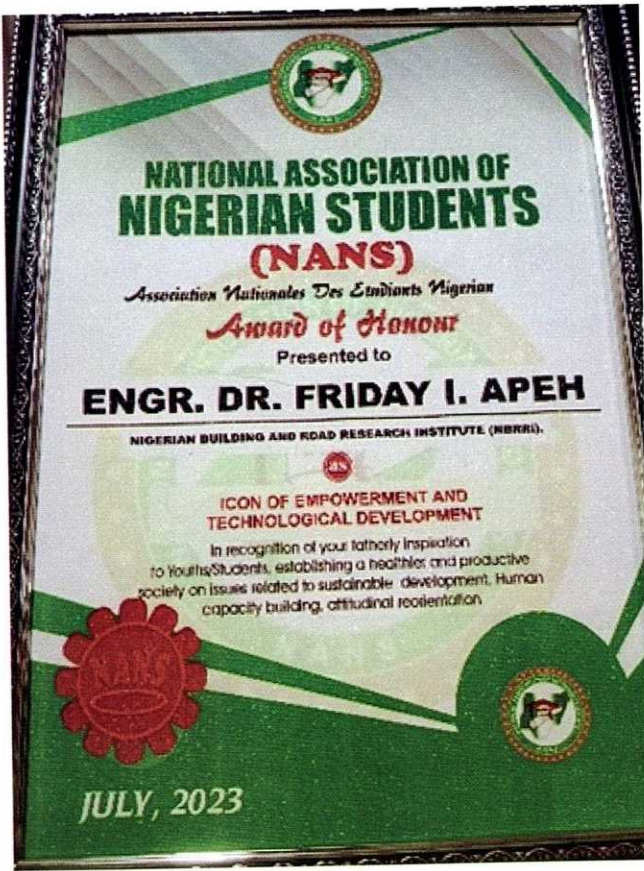
It was a great honour and much accolades on Engr. Dr. Friday Apeh a great and erudite engineer with vast knowledge in engineering materials and long years of experience in field work, the Head of EMRD on Monday 24th July, 2023 when the executives of the National Association of Nigerian

Presenting the Award of Honour to Engr. Apeh, the Chief of Staff of NANS, Comrade Jabir relayed the appreciation message of the body to Dr. Apeh for his fatherly role he has been playing to make sure that no student body that comes to him goes back unattended to. He stated that all



Students (NANS) led by the Chief of Staff of the honourable association Comrade Jabir Aminu Maituiare paid a visit to honour him at the NBRRI administrative head office in Abuja for his great work in the engineering sector and his selfless service to humanity and mainly students body.

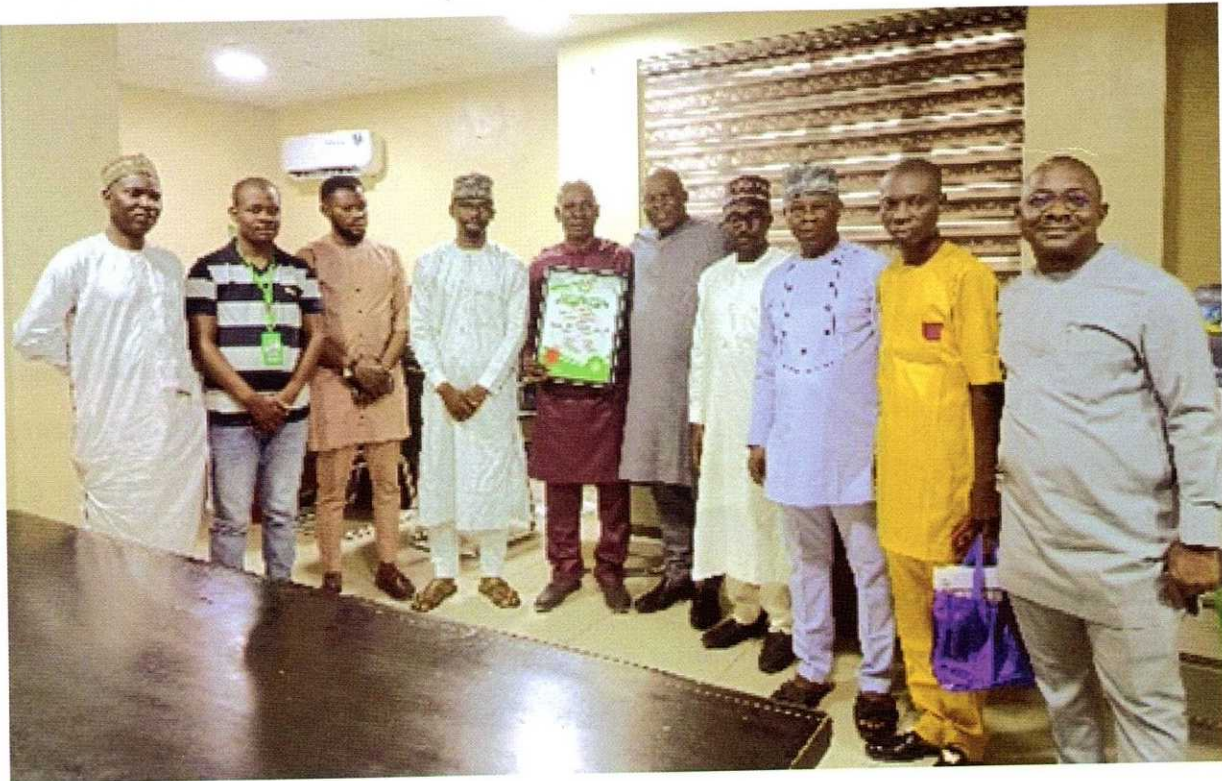
reports from the various students' body that have approached Dr. Apeh do come back singing his praise as a father to all. This he stated that the body finds Dr. Apeh worthy of emulating and so decided to honour him with an award.



Comrade Jabir also spoke highly of the effectiveness and love received from all staff of NBRRI and encouraged the institute to keep the good work.

Appreciating the students for the honour, Engr. Dr. Apeh explained that his services to humanity is geared towards his goal of building a better society in a little way he can. He then encouraged the students not to relent in motivating groups and individuals the find deserving of motivation and also, they should emulate good leadership styles such as that of Prof. Duna, DG NBRRI.

Dr. Apeh finalized his speech by appreciating the DG, Management and all staff of NBRRI as he stated that he alone could not have done these great things the students saw in him but it is a collaborative efforts and support from the institute in general.



NBRI DONATES ENGINEERING LABORATORY EQUIPMENT TO SIX FEDERAL UNIVERSITIES



The six Universities that benefited from this gesture on Wednesday July 26th 2023 at the NBRI Administrative Head Office in Abuja were selected based on the six geopolitical zones of the country as the equipment was aimed at strengthening the building capacity of the institutions and its related departments.

Handing over the equipment to the beneficiaries, the Director-General/Chief Executive Officer of NBRI Engr. Prof Samson Duna said

the intervention is timely considering the recurring decay of the civil engineering laboratory in the Nigerian Universities. Prof Duna speaks, "Stakeholders identified recurring decay in the Civil Engineering laboratories in the Universities and the effects it posted to engineering graduate". Speaking further, he says "We unanimously suggest that NBRI should take bold steps to curb the situation through intervention and provision of state of art construction materials among the Universities"

The DG added that these equipment are important at this moment that the country is faced with issues of building collapse. He explained further that every building has what we call grade, which is the quality of concrete, and that the positive impact of these machines is that it will help in giving the accurate value of the quality

of concrete, and if the quality of concrete is high, it means the resistance of the concrete is high. We want our buildings to have high - resistance concrete. So, the machine is like an assessor that tell you if the material is good or bad for construction purposes.



Lamenting on the effect of building collapse, Prof. Duna stated that various buildings in the country collapse as a result of their incapability which led to the loss of lives.

Professor Duna stressed that, in the year 2020 other Universities also

benefitted when the programme started which after the donation, NBRRRI went further to installed and trained some staff and students on the equipment usage.

He added that the machines would be distributed by its partners: Tectonics Engineering and Consults limited to the respective Universities for training of staff on the usage and installation.

Mr. James Sule, the Permanent Secretary, Federal Ministry of Science, Technology and Innovation in his speech challenged the institutions to make the best maintenance of the donated equipment.

He further said, "Let us not forget the responsibilities that comes with this, as we celebrate this milestone. it is an obligation for the academic institution and students to make the most of these resources by utilizing them to push boundaries of knowledge, seek sustainable solutions that are overwhelming and have positive development to the nation.

The former DG NBRRI, Engr. Professor Danladi Matawal while speaking urged NBRRI to set up a monitoring team that will be going round these institutions to ensure proper usage and working of the equipment. He further said that Polytechnics should be included in the

scheme since they produce technologists and technicians that man the laboratories in the Universities.

The benefiting Universities are: University of Abuja, University of Calabar, Abubakar Tafawa Balewa University Bauchi, Federal University of Technology Akure, Usman Dan Fodio University, Sokoto and Nnamdi Azikiwe University Akwa.

The Vice Chancellor, Usman Dan Fodio University, Professor Lawal Bilbis, speaks on behalf of the benefiting Universities, in his vote of thanks commended the efforts of NBRRI in seeing that the equipment are not just delivered, but also installed and are ready to train staff on the usage.

He stated that NBRRI has distinguished itself among other agencies to be the best in seeking better education and brighter future for the younger generations. He promised the institute that the benefiting universities will do all it takes to maintain and make good use of these equipment for the purpose of which they are been donated for.



The Director-General/Chief Executive Officer of the Nigerian Building and Road Research Institute (NBRRI), Engr. Prof. Samson Duna has once again emphasized the need to cultivate and apply the maintenance culture in order to sustain building structures for further use.

Prof. Duna made this assertion at the commissioning and handing over ceremony of a block of three classrooms to the authorities at the Dunama Primary school Lafia, Nasarawa State on Friday 4th August, 2023. Duna was represented by the Head of Building Research Department of the Institute in Abuja, Engr. Dr. Jibrin Sule who spoke at length on the durability of the NBRRI blocks stressing that due to this, "such buildings as being commissioned today are currently

replicated all over the country".

The construction of the block of three classrooms by NBRRI was activated by the Aliyu Bello Charity Foundation with its founder as Honourable Aliyu Bello, who also happens to be an alumnus of the Dunama Primary school. Bello, who was elated at the citing of the structure thanked the



Institute for such gesture and stated that the project is the Kickstarter for the 2023 Aliyu Bello Educational Empowerment Programme which is the first of its kind in the state.

He assured that, the Foundation is ready to always partner with NBRRRI and will take full responsibility for the maintenance of the structure.

There were goodwill messages from different stakeholders in the state and community including, a onetime head boy of the school (set 77), the PTA Chairman, the Director of the Directorate of Linkages and Advancement, Federal University of Lafia, Permanent Secretary, Ministry of Environment, Royal Fathers among

others.

Meanwhile, in his remarks and vote of thanks, the Executive Chairman, Nasarawa State Universal Basic Education Board, Hon. Mohammed Dan Azumi represented by Hajiya Hashim Mohammed, promised that the Board is also ready to work with the Foundation in the maintenance of the structure. She enjoined NBRRRI to situate more of such projects in the State.



NICE NATIONAL EXCO VISITS NBRRI TO STRENGTHEN BOND

It was another home coming and great idea sharing on Monday 21st August 2023 when the National Executive of the Nigerian Institution of Civil Engineers (NICE) paid a courtesy visit to the Director-General/CEO and the Management of the Nigerian Building and Road research Institute (NBRRI).



Speaking on behalf of the team from NICE, the National Chairman, Engr. Virgilus C. Ezugu, FNSE, FNICE, MASC who led the delegation stated that the aim of the visit to NBRRI is to foster a way forward in areas of construction, buildings and general engineering as it relates to the mandate of both institutions. He further stated that the NICE excos came with the foresight of building a stronger collaboration with NBRRI that will pave ways for better engagements with instructions and project execution.

Speaking further on other purposes of the visit, Engr. Virgilus explained that the institution is requesting NBRRI's participation in their forthcoming

National Conference which is slated to hold from 3rd to 5th October, 2023 and wants the DG NBRRI to deliver the Key Note address at the opening ceremony of the conference. He also solicited that the DG should encourage and sponsor the Civil Engineers in the institute to attend the conference. Furthermore, he informed the DG that NICE is currently working on publishing an Engineering journal that will help in project execution for engineers and the institution wants NBRRI's Engineers to send in their research papers for publication in the journal.



Addressing the delegates from NICE, the DG/CEO, NBRRI, Engr. Prof. Samson Duna welcomed the National Executive of Nice as he appreciates the visit and purpose of their visit. He spoke extensively on the mandates of NBRRI and some research achievements of NBRRI. He thereby encouraged the executive to do more in areas of construction according to international best practices and appreciated the idea of the engineering journal.

The DG in his magnanimity accepted to be the Key Note speaker in the forthcoming NICE conference. Also, he promised to encourage all Engineers in NBRRI Abuja office to participate in the conference and also appreciated the



request for staff to send in their research work for publication.

In his final remarks, the DG informed the executives about the forthcoming NBRRI International Conference which he stated that when the date is fixed, they will be duly informed for their full participation.

The visit was concluded with a group photograph and a tour round NBRRI's laboratories. The NICE delegates are; Engr. Virgilus C. Ezugu, FNSE, FNICE, MASCE (National Chairman), Engr. Sharafadeen Olumoh, FNSE (National Vice - Chairman), Engr. David T. Boaz, FNSE, FNICE, ACARB (Ag.

Executive Secretary), Engr. Zakariyya Abdulhakeem (Technical Secretary NICE-Abuja Chapter), Mr. Bright Ochiabuto (Admin Officer), Mr. Nasir Lawal (ICT Officer)

NBRRI'S TECHNOLOGY FOR EDUCATIONAL PROMOTION



Government and environs took place on Friday 1st of September 2023, with the DG/CEO of the Nigerian Building and Road Research Institute (NBRRI) Engr. Prof. Samson Duna ably represented by the Zonal Coordinator NBRRI (North-East Zone) Mr.

It was another remarkable gesture and show of great concern for better education in Nigeria by the Nigerian Building and Road Research Institute (NBRRI) at the occasion of the commissioning and handing over ceremony of a block of 3 classrooms and boreholes at Community Primary

Baba Yerima who emphasized at the commissioning event, the importance and needs for maintenance culture which he stated that it is a great call always emphasized by the DG for sustainability of infrastructures in the country.

School, Larbarfido and Government Day School, Lakurum respectively all in Billiri Local Government Area of Gombe State.



The ceremony which was graced by notable personalities and traditional rulers across the Local

Mr. Baba Yerima while speaking, appreciated the DG/CEO for this privilege of learning given to the masses and he also thanked the entire community for their corporation and assistance given to the contractor due to the difficult terrain,

means of accessing building materials in the community coupled with bad roads, but notwithstanding, today the projects are all great success.

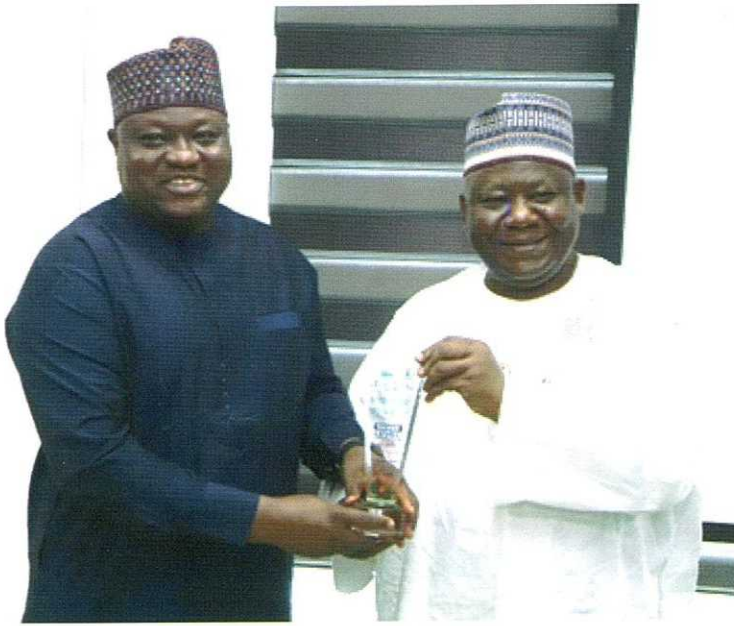
Delivering his goodwill message, His Royal Highest the Hakimi of Tal, Mallam Shuaibu Anampara appreciated the DG and the entire Institute for such a huge and kind gesture. Speaking further, HRH expressed satisfaction on the numerous contributions by NBRRI to various communities in the Local Government as he also stated that Prof. Duna is exhibiting the true meaning of his traditional title as 'Sarduwna Tal' which means 'Man of the People that loves to see good things happen to people'. He stated that the suffering of good drinking



water by the people in the communities has been eradicated by this gesture of providing boreholes alongside the school buildings for the communities.

Also expressing his appreciation on the kind gesture at the occasion was Rt. Major B. S, Oba, the chairman of one of the communities who gave the vote of thanks on behalf of both communities. He prayed for higher height for NBRRI and enjoined the end users of these facilities to listen to the advice of the DG by abiding to the maintenance culture preach by the DG.

BUREAU FOR PUBLIC SERVICE REFORMS SCORES NBRRI



In November 2019 and February 2021 respectively, the government of the Federal Republic of Nigeria tasked the Bureau of Public Service Reforms (BPSR) to facilitate the deployment of the Self-Assessment Tool (SAT) in all Federal Ministries, Departments and Agencies (MDAs) and submit status report to the Office of the Secretary of the Government of the Federation. In view of this, the Bureau deployed the Tool in Nigerian Building and Road Research Institute (NBRRI) in 2022 for the Self-Assessment exercise. As a result of this exercise, the report/findings by the Bureau was officially presented to the DG/CEO NBRRI on Wednesday 13th September, 2023 at NBRRI's Headquarters, Jabi, Abuja.

While presenting the report, the Director-General of the Bureau Dr. Dasuki Ibrahim Arabi explained the core values, needs and purpose of conducting the exercise which is to find a lasting solution on improving the work output of Civil Servants and boost the Civil Service in the country to meet up with

international standards. Speaking further, Dr. Dasuki expressed satisfaction on the findings from the exercise in NBRRI as the team who conducted the exercise scored NBRRI



high based on performance index and meeting up to required target of NBRRI's mandates. Dr. Dasuku also encouraged the institute not to relent in its services to the nation and to work more on collaborations and publicity

for the institute has done much and has more to offer to nation building.

The event also saw the presentation Excellent Performance Award to NBRRI by BPSR. While presenting the award, the DG BPSR, Dr. Dasuki stated that the award is to boost the morale of staff of NBRRI and appreciate the

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the Director-General/Chief Executive Officer of NBRRI, Engr. Prof. Samson Duna for his leadership style and great work he is doing in repositioning the institute and promoting it to limelight.

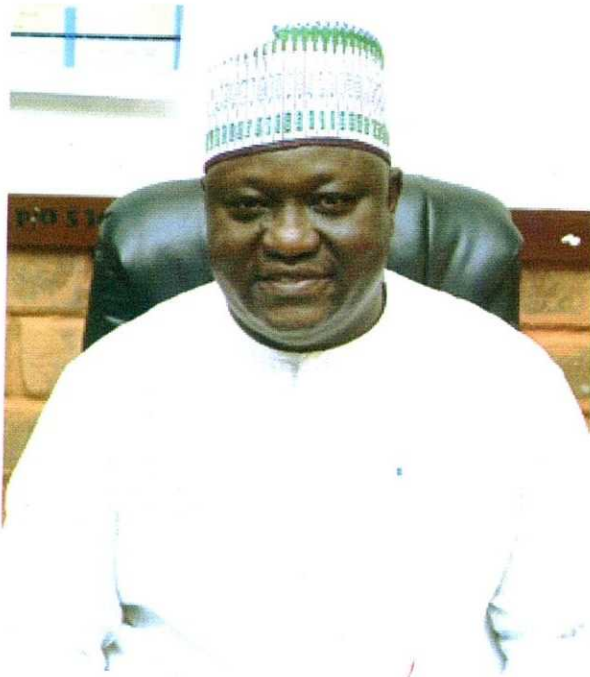
Receiving and appreciating the report and award, Prof. Duna stated that these positive reports cannot be achieved if the staff and management of NBRRI are not up and doing. He attributed the

success to dedication to work from staff of the institute as he also encouraged staff to do more stating that the nation can only attain the desired economic growth when all citizens at all levels do their best to impact the country positively. He also appreciated the DG and Staff of BPSR for the exercise and awards as he encouraged them to

be focused in building the country through a vibrant civil service.

Also speaking and appreciating NBRRI and BPSR is Dr. Chinyere Nwoye, President, Chosen Vessels Global who came in from the United States and happened to be present at the occasion. Dr. Chinyere encouraged both agencies to put the country's goal first before any other thing so as to have a better Nigeria.

DG NBRRI SPEAKS ON ALTERNATIVE BUILDING MATERIALS AT NSE FORUM



As the keynote speaker at the investiture of the 13th chairman, inauguration of new executives, induction of new members and conferment of awards on deserving members of the Makurdi branch of The Nigerian Society of Engineers held on Saturday 16th September 2023, Engr. Prof. Samson Duna, Director-General/Chief Executive Officer of the Nigerian Building and Road Research Institute (NBRRI), spoke extensively on the "Alternative Building Materials as a Panacea for Addressing Housing Challenges of Low Income Earners". In his speech, he mentioned that the importance of building in the society cannot be overemphasized, in addition to accommodating human beings, it

can also be used as a tourist center and depicts culture of the people. He also stressed that, the Alternative Building Materials (ABMs) are regarded as friends of the environment because they are recyclable, reusable and have zero effects on the environment. Prof. Duna said, according to a publication by the Central Bank of Nigeria (CBN), Nigerian housing deficit was at 7 million 1991 and rose to 12 million in 2007, 14 million in 2010 and 20 million in 2019. He said according to the Federal Mortgage Bank of Nigeria, it is currently at 28 million as at January 2023, this means that, 28 million people or more are homeless. He further describes the Alternative Building Materials as modifying conventional industrial materials or unconventional/indigenous/traditional materials or modifying unconventional/traditional/indigenous materials which are particularly attractive for housing. He finalized by encouraging builders and contractors to patronize local contents and see the economic and environmental benefits in the use of Alternative Building Materials.

NBTI TO PARTNER NBRRI TO PROMOTE LOCAL CONTENTS



Dr. Patricia Uchenna Chukwu, Director-General of the National Board for Technology Incubation (NBTI) on 18th September 2023 emphasized the needs for collaborations among Federal Government Agencies mainly in the promotion of local contents and commercialization of locally manufactured goods developed from R&Ds of these Federal Government's Agencies. This she stated when she alongside her management staff from NBTI paid a courtesy visit to the Nigerian Building and Road Research Institute (NBRRI) in Abuja. Presenting her speech and explaining the purpose of the visit, Dr. Patricia stated that based on her findings and enquiries, NBRRI is considered as the best and most hard-working agency among the agencies in the Ministry of

Innovation, Science and Technology; hence her first place to visit since her assumption of office as the new DG of NBTI. The visit is meant to have a synergy between the agencies under the ministry, and she planned on embarking on courtesy visits to other related agencies in order to enable them share ideas and explore opportunities for collaborations, she explained. Accordingly, Dr. Patricia expressed confident in the proposed partnership between the two agencies has she briefed the audience that the collaboration would make a brighter and more and more technologically advanced Nigeria to support the research and development power.

CEMENT AND CONCRETE: ADVANCES IN RESEARCH AND APPLICATIONS

(Being a keynote address to the Annual General Meeting of the Nigerian Institute of Building tagged 'TIN CITY 2023' on Tuesday 16th August 2023 in Jos, Nigeria)

By **Professor Danladi Slim MATAWAL** (former DG/CEO NBRI)

Abstract: Cement is currently one of the most popular materials in the world today being used for the production of concrete in the construction of Buildings and Critical Engineering Infrastructure. Conventional Cement is a fine powder created from crushed limestone and clay which acts as a glue-like binder to hold the Concrete together. On the other hand, Concrete is the finished product that results from mixing sand, water, admixtures, and cement together. References to both Cement and Concrete are almost interchangeable but their use is very old, like the Roman Empire was the first civilization that used concrete for building houses from a mix of pumice, pozzolana, and lime to make concrete with one of the largest concrete domes that was built in 120 A.D. being the former Roman temple, Pantheon in Rome still standing today. Therefore, with the established and old-age practice and reliance on Cement and Concrete, it will be surprising that there can be any doubt about its use at all. However due to many reasons

related to cost of cement and hence concrete; and construction as well as the need to evolve new similar products of higher early and long-term strengths, better workability/placeability and mixability, obtain better sealant qualities especially for water retaining structures and roofing concrete covers; as well as numerous other reasons, the search for better and cheaper glue products in partial or complete replacement of cement has been in the front burner of research and development as long as the history of concrete itself. Hence this presentation though acknowledging that today, Portland cement is among the most commonly used and widely available types of cement around the world, being one of the most cost-effective construction materials; nonetheless takes a huge moderating glance that numerous abuses are associated with the use of cements and concretes because of the lack of understanding of the technical scientific principles,

deep theoretical knowledge and engineering applications for best practice and expected huge beneficial outcomes on application. Furthermore, with deluges of advances in research and development (R&D), many other types of Cements, apart from OPC, are available and in use, including supplementary cementing materials, SCM. Concrete replacements are now available as cheaper and optional construction products and cement

additives leading to concrete strengths in excess of 170N/mm² for Polymer Cement as example, are currently available. Drawing from experience of the author and some literary works on the subject matter, a detailed presentation is made for better and more thorough understanding in the embrace and application of Cement and Concrete in theory and practice, especially for the Nigeria construction industry.

1. INTRODUCTION: WHAT IS CEMENT AND CONCRETE



Concrete is often confused with cement since both are used synonymously, but in the most basic sense, they are not one and the same. Conventional cement is a fine powder created from crushed limestone and clay. These materials act as a glue-like binder to hold the concrete together. Apart from limestone and clay, cement can be made from many other

materials, but it cannot usually be used on its own. In the old days, cement was made from burnt limestone, bricks, volcanic ash, and crushed rock. Today, Portland cement is among the most commonly used and widely available types of cement around the world, being one of the most cost-effective construction materials. Because of advances in research and development (R&D), it would be seen later that many other types of Cements, apart from OPC, are available and in use, including supplementary cementing materials, SCM.



Figure 1: (a) Cement/Cement Bricks, and (b) Finished Concrete Surface

On the other hand, concrete is the finished product that results from mixing sand, water, admixtures, and cement together. This mixture must be used whilst it is in a wet state before it solidifies over time. Once the concrete mixture has hardened, it will gain strength and durability. The Roman Empire was the first civilization that used concrete for building houses from a mix of pumice, pozzolana, and lime to make concrete. The largest concrete dome that was built in 120 A.D. is the former Roman temple, Pantheon in Rome. Concrete comes in varying strengths and appearances and is typically made from 4 key ingredients, which we must distinguish from the chemical compounds that form cement and are

critically influential to its inherent properties and behaviour. These include:

- Water: the most crucial element of concrete is water. The quality of concrete is determined by how much water is used. Water creates a chemical reaction when it comes into contact with cement. It also aids workability as long as the right ratio of water to cement is used.
- Cement: this is the binding ingredient that holds all the materials together.
- Fine and coarse aggregates: sand and stones
- Admixtures: other than cement, water, and sand, admixtures are also used before or during the mixing process. Some examples of admixtures include silica fumes, slags, and water reducers.

Just for possible reiteration, cement is an excellent construction material that is used for its high binding strength virtually in every building work and especially in structural elements where high strength is required at an early period of time. Much technical

materials that is highly favored by both commercial and residential builders. However, because cement is actually an ingredient in concrete, the two materials may not be the same but in application, they are not even complementary but just one and the same stuff. Concrete is a mixture of cement, water, and aggregates, whereas cement contains limestone and clay. So we can safely say that concrete needs cement in order for it to be used in building projects. Cement comprises up to 15 percent concrete mix through a process known as hydration, where the water and cement bind together; this hardening process turns into concrete.

2.2 Concrete is fundamental in shaping our world: Concrete's inherent benefits of strength, durability, resilience, safety and affordability is harnessed to create vital infrastructure; be it road pavements and infrastructure like culverts, drainages, road barriers; bridges, railways especially the sleepers when steel ones are being stolen; buildings as homes and offices; or the cities and even country homes we live in. It is useful in sidewalks as it is in tunnels, pile and caisson foundation structures, etc. Concrete is crucial for the transition towards global sustainable

development and more generally for the infrastructure to support clean energy development. Concrete also plays a significant role in the energy efficiency of buildings. As a mixture, the exact ratios and mix, and type of aggregates used depends on intended application. One of concrete's key assets is its versatility which means concrete can be used in a variety of ways to solve the many needs that individuals and societies have - shelter, housing, providing clean water and sanitation, transport, business and commerce; it is indeed an extremely strong, durable and resilient material. Looking back and now, Cement and Concrete have a long history of use in our world. Briefly, The Roman Empire accelerated the use of concrete; some of its most famous buildings still stand today built around 2,000 years ago, demonstrating the resilience and durability of concrete. Although the cement that was used was different to today's cement material - the principle was similar. Today Portland clinker-based cement is the most common type of cement in use. Portland cement was first developed in the beginning of the 1800s. All members of the GCCA (Global Cement and Concrete Association) are Portland clinker-based cement producers.

2.3 The Importance of Cement and Concrete in Construction Because this amazing material has several different uses and is widely used in the construction of all over the world, concrete constitutes the most famous material used for construction purposes.

In many countries, especially Europe, Japan, America and China, 'ready-mix' concrete has become really popular in recent years to speed up the construction process and make it more reliable and now a fashionable avenue of business for the professionals in the construction industry. Concrete is used to provide strength, durability, and versatility during the construction of any structure. These excellent properties have made concrete a reliable and long-lasting choice of construction for companies for both commercial and domestic types of constructions. Some of the primary, or better fundamental properties of concrete that make it extremely important in construction as a preferred material are:

I. Strength: Strength is the primary reason why concrete has been used by housing developers and construction companies for many decades. As Reinforced Concrete, it is a solid material that possesses the ability to resist both compressional and direct or flexural tension, shear and torsional stresses. In 'ready mix' concrete construction companies can now look up to reliable concrete suppliers that provide the best readily available concrete mixes, turning it into proprietary material for the purpose of producing best quality for efficient applications. Maybe this is one of the established advances globally that we must take note of at this nascent stage of this address. The strength of concrete has made it essential in the construction of buildings, foundations, water treatment facilities, factories, bridges, large industrial sectors, and other many other types of structures. The strength of the concrete is adaptable to specific requirements of a construction project.

information on Cements in particular can be found in my inaugural lecture (Matawal 2002) that delves into great details about the types of cement, ranging from general use type I to higher strength type II and III as well as types IV and V. But as a construction material independently, Cement cannot be used for large-scale construction works since it has higher heat hydration than concrete, its durability is low, and it is less solid than concrete and prone to cracking. On the other hand, Concrete ingredients are easily available in every location, unlike stone it has no flaws or defects, it is highly durable and can be made into any shape, casting process can be done on-site which is economical and time-saving. Further, concrete can withstand extreme temperatures and even though concrete absorbs water, it is a mix of cement and other stuff that is not as porous as cement, and it is also an excellent soundproofing material. But on the whole, Cement and Concrete are intertwined in the minds of many people, but so also are they truly so in actual fact. In another sense, we can assert that Concrete is the material that we interact with every day - in the structure of our homes, offices and hospitals,

supporting our bridges and infrastructure, laid on our roads and pavements. Cement is the vital glue that binds the ingredients of concrete together and makes concrete the truly versatile and beautiful building material that is solving the needs of the world today and addressing the challenges of tomorrow. Cement as a glue, acts as a hydraulic binder, meaning it hardens when water is added. Cement itself is a fine powder that is made by first crushing and then heating limestone or chalk, with a few other natural materials, including clay or shale, added. The ground base materials are heated in a rotating kiln to a temperature of up to 1450oC or as hot as volcanic lava.

2. THE IMPORTANCE OF CEMENT AND CONCRETE IN CONSTRUCTION

2.1 Scope of Applications: Whether you use concrete on your walls, sidewalk, or floor, this building material is known for its longevity. Concrete has a great reputation for lasting hundreds of years while on the other hand, Cement is much less durable and prone to cracking. While cement is only suitable for smaller jobs, concrete works very well in both large and small projects. Concrete is one of the longer-lasting and sturdiest

ii. **Durability:** Concrete can last for ages as it can survive harsh weather conditions and natural disasters. It is resistant to extreme weathers, rusting, chemical reactions, fire, erosion, compressive and tensile stress, and abrasion. As a result, the structural integrity of the concrete will not be undermined for an extended period of time which makes it suitable for every other place in the world. The high durability of the concrete means it is a long-lasting construction material for permanent buildings and strong structures like bridges and dams. The first concrete dates back to about 500 BC and we can still observe concrete of ancient times.

iii. **Versatility:** Concrete has applications in different types of

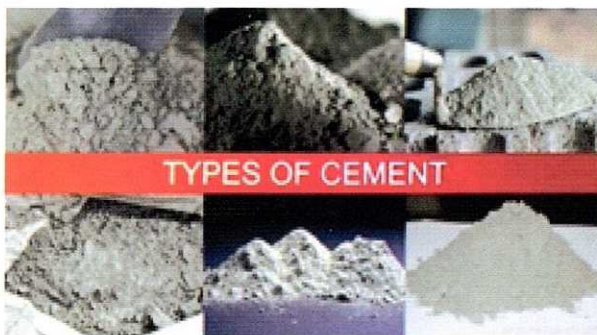


Figure 2: (a) Cement Types, and

So far as the growth and survival of human societies are concerned, cement and concrete are therefore essential components. As a foundation and building block of long lasting and reliable infrastructure, concrete has remarkable performance across social,

construction materials. Its versatility makes it easy for the construction companies to use it for building roads, highways, sidewalks, garages, and any other structure. Its strength can be modified according to the construction requirements. Concrete can be formed into any shape and size to develop unique, creative and innovative structures and designs.

iv. **Environmental Importance of Concrete:** Concrete also has numerous environmental benefits, such as: survival natural disasters like floods; being recyclable and reusable, which increases its lifespan even further; and minimal transportation is required for the raw materials of the mixture as it is usually found from the local sources



(b) Fresh Concrete

economic, and environmental aspects. It would become difficult to provide economical, low maintenance, and efficient infrastructure to service large cities without cement and concrete. The byproduct concrete is robust, affordable, and abundantly available.

While infrastructure is imperative to develop modern societies, concrete is the best building material from which sustainable infrastructure is built. Undoubtedly, concrete is the ideal choice to build sustainable cities.

2. COMMON CONCRETE PROBLEMS AND RESEARCH SOLUTIONS: The cost of repairing, replacing and rehabilitating deteriorated infrastructures in Nigeria and across the world is becoming a major concern. The dire need to upgrade the structural capacity of our existing bridges and ageing infrastructure with modern and advanced building materials has been growing in popularity over the years. As illustration, Corrosion of reinforcement in concrete structures is a serious diffused deterioration phenomenon. Chloride attacking the carbonation of the concrete exterior is what leads to rebar corrosion and heavy maintenance requirements. Indeed, while concrete is a relatively convenient material to manage, however the construction industry has been dealing with a number of structural issues associated with cement concrete and concrete reinforcement. The rapid deterioration of many concrete infrastructures

makes it difficult for the government to maintain or upgrade existing structures which would cost billions to trillions of naira every year to be effectively remediated. Intricately, other demerits associated with its principal compound cement make the search for other binders both unavoidable and inevitable. Concrete itself is subject of cracking, disintegration, spalling, discoloration, scaling, curling, and crazing, being some of the common concrete problems. So when the question is asked about why do concrete structures such as bridges and buildings fail so frequently and flagrantly too in Nigeria or become structurally deficient, it is possible that deterioration of old public structures is factually a huge challenge for structure owners. The construction industry has been struggling to effectively address the corrosion of reinforcement which is the biggest reason why concrete deteriorates. When traditional reinforcement material such as steel corrodes, the process ultimately leads to concrete problems. Generally, corrosion of steel in concrete is induced by either carbonation or by chlorides. Carbonation means that carbon dioxide in air reacts with calcium within the concrete.

This means that the pH of the concrete is decreasing and the steel start to corrode. In Nigeria, the poor application of Cement and concrete has led to collapse of Buildings.

cement industry is one of the leading producers of carbon dioxide. Growing consumer awareness of climate change and the environmental impact of construction has some clients



Figure 3: NBRRI and Building Collapse in Nigeria (i) 1-Storey at Bukuru and (ii) Imam Street, Uyo

Hence even though concrete remains one of the most popular materials in construction and is second only to

looking for alternatives to materials that rely on cement. There is a growing range of concrete alternatives using



materials which provide similar benefits as concrete, like strength, durability, and longevity, but at a lower carbon cost, with less



Figure 4: Typical Carbonation and Reinforcement Corrosion Effects in Concrete

water in terms of material consumption around the globe, however, drawbacks like the material's high carbon impact can make it unattractive for some projects. Shifting to its major compound, the

environmental impact, and often with an appealing and distinctive appearance. Other problems of cement are tied to its disadvantages, namely: Contrasted with other binding materials, the tensile

strength of cement is somewhat low, Cement is less ductile, the weight in contrast is high compared to its strength, Cement may contain solvent salts which cause efflorescence.

The 5C framework is structured around the key elements of the cement

and concrete value chain: clinker, cement, concrete, construction and the built environment, and (re)carbonation. For Climate solutions, the focus for cement and concrete industry, the key discussions target pathway to carbon neutrality.

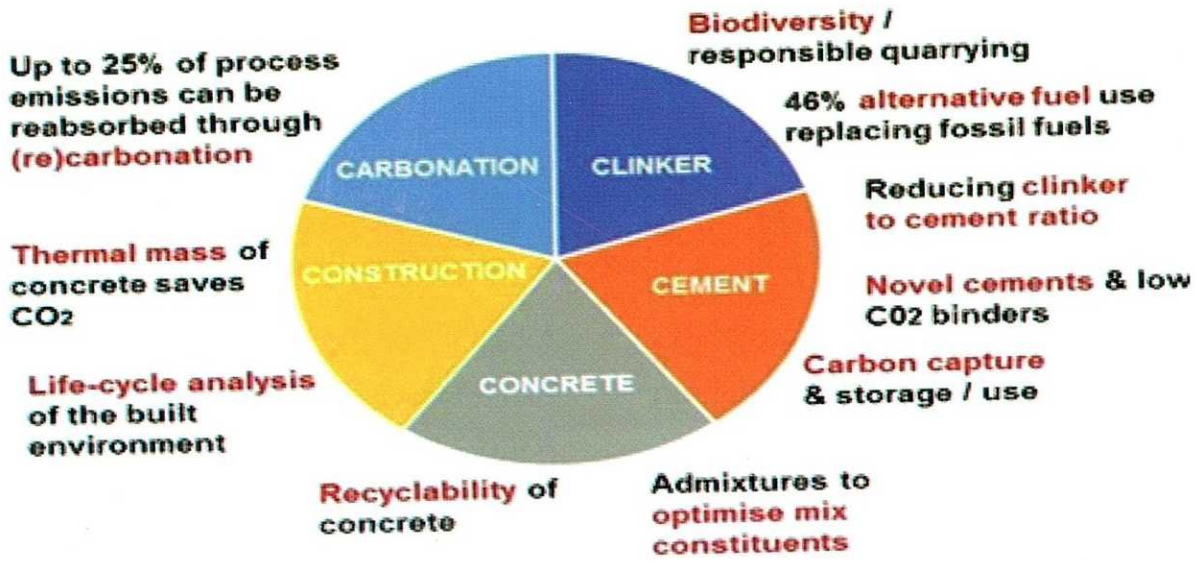


Figure 5: Innovation along the value chain: the 5C approach

The usual aims of research in Cement and Concrete are to investigate and improve upon the materials science and engineering of cement, cement composites, mortars, concrete and other allied materials that incorporate cement or other mineral binders. Usually there is focus to obtain results and make breakthroughs on the properties and performance of cementitious materials; novel experimental techniques; the latest analytical and modelling methods; the examination and the diagnosis of real

cement and concrete structures; and the potential for improved materials with a view to cover:

- Processing: Cement manufacturing, admixtures, mixing, rheology and hydration with emphasis on advanced cements - Portland cements, and other mineral binders such as aluminosilicates (often referred to as geopolymers), calcium aluminates, calcium sulfoaluminates, magnesia-based cements, as well as lime and/gypsum-based materials.

Chemical, microstructural and structural characterization of the unhydrated components and of hydrated systems including: the chemistry (structure, thermodynamics and kinetics), crystal structure, pore structure of cementitious materials, characterization techniques, and the modelling on atomistic, microstructural and structural levels.

The properties and modelling of cement and concrete, including: fundamental physical properties in both fluid and hardened state; transport, mechanical and other properties; the processes of degradation of cementitious materials; and the modelling of properties and degradation processes, as a means of predicting short-term and long-term performance, of relating a material's structure to its properties and of designing materials of improved performance, in particular with lower environmental impact. Corrosion related to process fundamentally affected by the interplay between steel reactivity and a surrounding cementitious material are good areas.

Applications for cement, mortar and concrete keeping a clear focus on fundamental questions of materials science and engineering focus that include: concrete technology, rheology control, fiber reinforcement, waste management, recycling, life cycle analysis, novel concretes and digital fabrication.

The construction industry has developed many techniques and materials to counter steel corrosion. Unfortunately, none of the techniques may be effective enough to address the problem but there are short term solutions that slow down the corrosion process while others introduce advantages to the many observed disadvantages of cement and concrete. Economy is one area which demonizes cement and concrete, especially in Nigeria where inflation has deeply undermined not only the capacity but also the probability (even possibility) of individuals owning homes and for most governments to intervene in affordable and/or social housing effectively. This is where GFRP concrete reinforcement offers the civil engineering community an innovative and reliable way to effectively encounter steel corrosion. There are also issues of workability or

mixability/ placeability of concrete, setting times, strength and durability in Cement and concrete.

Glass fiber reinforced polymer (GFRP) is inherently corrosion-resistant and lightweight material which offers many advantageous structural properties ranging from ease of construction and low maintenance to electromagnetic neutrality and 2x tensile strength and one of my students is working on metakaolin from Alkaleri Kaolin mines as geopolymer concrete and substantial progress has been recorded. Research must focus on novel strategies for reducing CO₂ emissions in cement production, carbon sequestration into cement, the identification of new agents for enhancing durability, the

There may be environmental and economic advantages of utilizing refuse-derived fuels (RDF) and sewage sludge (SS) in cement kilns to decrease CO₂ emissions of clinkers in order to significantly reduce the carbon footprint of cement production, a major source of greenhouse gas emissions. Alternative materials and innovative mix designs are being explored to improve concrete performance, the effects of partially substituting cement with rice husk ash, corn cobs, volcanic ash derived from some locations on the Jos plateau and even solutions for cement on the permeability and carbonation resistance of concrete. Use of tin mining ore and iron ore tailings as well as granulated blast furnace slag and quartz powder ha



Figure 6: (a) Collapse of 21-storey Apartment Block in Ikovi-Lagos, and (b) Other Structures

development of ultra-high-performance concrete (UHPC) with compressive strengths exceeding 170 MPa, radiation shielding, and the enhancement of the durability of concrete in extreme environments by employing mix designs.

their unique effects on concrete strength and durability and they have been studied as well as even employing wood ash as a partial substitute for cement for desired effects on concrete strength and durability.

"Innovation in the manufacture of novel low-carbon cements and the widespread use of waste derived fuels are two keys to achieve an immediate reduction in the Co2 emissions of the Spanish cement industry. The replacement rate of fossil fuels by waste derived fuels Europe is above 60%."

4. SOME OPTIONAL MATERIALS TO CONCRETE IN CONSTRUCTION Despite its durability, versatility, and undeniable presence in our environment, concrete

greener alternative to concrete that replaces about 97% of its constituents with recycled material, thus discarding the use of traditional cement. It not only reduces costs but also provides greater strength and durability when compared to traditional concrete. Fly Ash also reduces the shrinkage and permeability of concrete and renders it resistant to alkali-silica reactions. Ashcrete has a wide range of applications and can be used in bridges, pavements, embankments, roads, and building.



Figure 7: Fly Ash from Coal Power Stations

is a major contributor to the emission of greenhouse gases and that can only mean bad news for the climate. The building industry today owes a long due apology to nature and using greener substitutes for concrete could lead a long way forward. There are some known substitutes that ace the sustainability charts over concrete and can be an alternate solution that offer a lower environmental impact, and even much lower costs.

4.1 Ashcrete: Fly Ash is a by-product of coal combustion that is otherwise discarded into landfills. Ashcrete is a

4.2 Recycled Plastic: Plastic has an indisputable presence in our everyday life, unlike any other material. The non-biodegradable plastic waste, hence caused, has created havoc in the environment today. The use of recycled plastic in construction is a strategic way out to reduce the emission of greenhouse gases while unclogging the plastic-filled landfills. Plastic waste can be easily recycled and replace 20% of aggregates in concrete.

The plastic-filled concrete block thus formed is lighter although its use in taller structures may be questionable. It may also be noted that only 9% of the total plastic that is produced can be recycled and therefore newer technologies suggest widespread use of non-recyclable plastic in various facades of construction. It is currently

about 80% less carbon as compared to traditional cement and therefore Hempcrete can be said to test carbon negative. It provides natural insulation and flexibility to the structure. One of the drawbacks of this material is that it cannot be used in load-bearing walls since it takes a long time to cure. Yet newer innovations have developed



Figure 8: Plastic Bricks made from used Water Bottles

gaining momentum in the area of road construction. Nevertheless, re-using plastic would be nothing less than a miracle for our environment.

Hempcrete: The hemp plant is a fast-growing renewable resource. To put it in perspective, it takes about four months to grow and can be harvested in perpetuity, unlike forests and has little or no demand for water, chemicals or fuel. Hempcrete is a relatively new and biodegradable alternative to concrete. Hemp fibers when mixed with lime and water, create a concrete-like material, but lighter and stronger. Lime releases

hempcrete blocks that can be used as bricks for construction. Hemp renders a certain natural texture to the wall which can be enhanced as an architectural quality.

4.4 Ferrock – Steel Dust: Reduce, Reuse and Recycle is the key 'mantra' to a sustainable future. Ferrock, a steel-dust version of concrete, uses recycled waste from steel and glass manufacturing industries to create an environment-friendly building block. It is five times stronger than conventional concrete and can withstand more compression before

breaking, making it a potential material that could resist earth movements caused by earthquakes or industrial activities. So what's more in store for this material? Apart from turning tons of waste steel dust into useful material, ferrock has a greater and greener benefit as compared to cement. It requires a great amount of carbon dioxide while hardening, thus

from fungi that runs below the ground. They can grow around other organic materials such as straw and when dried and processed can be turned into a building material of any specific shape or form. The mycelium bricks are much lighter and durable, resistant to fire, water and mold. This organic material has wider applications and is only taking baby steps in the

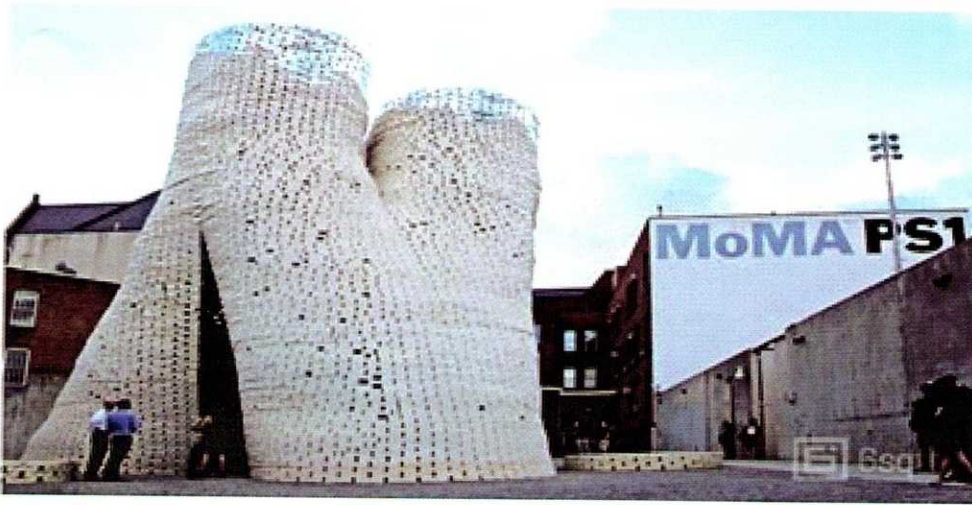


Figure 9:
Mycelium
Tower

absorbing and trapping the greenhouse gas, which makes it a carbon-negative material. Still in the process of research, it holds the potential to be used in mainstream construction.

4.5 Mycelium - Mushrooms: If you are not sure you read the heading right, read it again. YES! Mushroom is the next most promising technology that shall reduce our ecological footprint and lead the way into a sustainable world. Mycelium is the root-like fiber

construction world. It is currently being used as packaging material, art installations, and other products at a smaller scale. In 2014, a group called 'The Living' erected the first mycelium brick tower. The benefits of large-scale applications would be countless.

4.6 NBRRI Pozzolana: For a number of reasons, such as strength, adequate durability, workability, degree of hydration, degree of chemical resistance, gel-space ratio, economic reasons, etc. a number of mineral

admixtures have been used presently either as blended cements or as additives in concrete. Pozzolans are commonly used as an addition to Portland cement concrete mixtures to increase the long-term strength and other material properties of Portland cement concrete, and in some cases reduce the material cost of concrete. NBRRI has established pilot plants at Bokkos and Ota and produces

Cement Stabilized Earth Blocks.

5. NEW AND CURRENT CEMENT CLASSIFICATIONS Based on challenges of application and results of research, we can reclassify Cement comprehensively into two categories - Hydraulic and Non-Hydraulic contingent upon how they react to the presence of water, being



Figure 10: NBRRI Pozzolana Pilot Production Plants at Bokkos and Ota during Commissioning (NBRRI Calcined Clay Pozzolana Bags inset)

pozzolans whose potency is espoused in the section on supplementary cementitious materials. Its embracement through applications would offer opportunities for affordable housing developments, National industrial development and general socio-economic development of the country as a whole.

4.7 NBRRI Bricks: NBRRI Interlocking bricks are also important supplements to concrete in housing and numerous applications for walling in schools, public and private applications as by-products through

Hydraulic Cement - This cement gets hardened or solidified in an extremely short span to focus in constructions for saving time and energy. The basic parts are limestone, clay, and gypsum blended in exceptionally high temperatures to create areas of strength for an impact. The advantage of these cement types is that they are impervious to weather conditions changes even in underwater conditions like tanks, pools, and so forth; they are additionally

- Non-Hydraulic Cement - They have an extremely long setting period and can only work in dry circumstances. Non-hydraulic isn't pragmatic for business developments, as they can't be utilized in sites that are available to weather conditions challenges. Made with lime, gypsum, and oxychloride, this cement can't be utilized for water-related constructions and are rigorously reserved for indoor purposes to accomplish structural strength.

Thus, we have Ordinary Portland Cement (OPC) falls under the hydraulic category and is acquired by heating the Argillaceous (clay and shale) and Calcareous (limestone, chalk, and marl) in exceptionally high temperatures, called the Calcination process. The end product is known as the Clinker, which is then crushed into a fine powder and afterward blended in with Calcium Sulfate and Gypsum to make cement. This is the most well-known type of cement utilized for general construction and development purposes. It promptly responds with water and has quick dry characteristics.

Portland Pozzolana Cement (PPC) whose fundamental component is Pozzolona, which incorporates materials like fly ash, volcanic debris, or calcined clay. This cement is prepared in two ways - one by crushing or grinding the Pozzolanic clinker with conventional Portland cement or adding Pozzolana with gypsum or calcium sulfate. Another method is to mix the Portland cement with powdered Pozzolana. It is highly impervious to chemical attacks and falls under the hydraulic cement types. They are suitable for marine

constructions, pre-casted sewage channels, dams, etc. They Can be used for creating concrete artworks, as it lends a smooth and glossy finish. Portland pozzolana cement is available as 25kgs sack bags in the current NBRRI Pilot plants in Bokkos and Ota.

Quick Setting Cement whose name emanates from its quick-setting properties as it sets in quick time just in 5 minutes, with 30 minutes as the final setting time. The cement is of a proportion of Clinker and Aluminum Sulfate to increase the hydration rate. They are accessible in 25kg, 40kg, and 50kg bags.

Low Heat Cement is a unique type of cement that releases low heat of hydration, which is a chemical reaction that happens when the cement gets blended in with water. The benefit of generating lower heat of hydration is a limited risk of cracks on the body. This cement is prepared by bringing down the proportion of Tricalcium Aluminate by 6% and increasing Declaim Silicate to 46% to forestall cracks because of high heat. They are utilized in mass construction sites like dams, bridges, massive foundations, enormous slabs, chemical plants etc. They are less reactive cement and have a higher setting time contrasted with the regular OPC.

Rapid Hardening Cement for Sites that demand faster construction and development in a lesser time window, rapid hardening cement is the most ideal decision. As the name recommends, it sets in only 30 seconds initially and 600 minutes as the final setting time. The key to this strength lies in its formula which contains a

frequently alluded to as Calcium Aluminate cement or Aluminous cement. This cement has a very high compressive strength and is fire-resistant, making it suitable for large constructions; prepared by melting bauxite and lime mixture and then grinding it with a clinker. They are suitable for building sites subjected to



NBRRI Interlocking Bricks

Figure 11: NBRRI Interlocking Brick Application for Duplex Housing in a Nigerian University

higher percentage of Tri-Calcium Silicate than regular Portland Cement. This cement needs 3 days to totally create or harden contrasted with a 7-day window of a traditional OPC. They Can be utilized for road repair works, pavements, and pre-fabricated constructions. Rapid hardening cement isn't suggested for mass construction sites, as the risk of developing cracks is extremely high.

High Alumina Cement is made of Calcium aluminates, rather than the Calcium silicates utilized in regular Portland cement. Therefore, it is

extreme weather conditions like high temperatures (or frost). There are also White Cements (reducing or diminishing the extents or proportions of iron oxide and manganese oxide) with water-resistant properties typically utilized as a grout to set the tiles on the flooring, in pools, and in other interior and exterior decorative works, but very expensive. Also Sulphate-Resisting Cements developed in light of the sulfate attacks on the cement in a concrete structure. Sulfate-resisting cement falls under the hydraulic cement category.

It is made by reducing or decreasing the amounts of calcium sulpho aluminates like C3A and C4AF. This is an ideal choice for construction sites wherein the soil or groundwater contains high amounts of sulfate salts like seacoasts, flowing regions, or locales nearer to the sea waters. They are ideal for water storage sumps and drainage or seepage works.

Air Entraining Cements are alternate cement variety that has an addition of a limited amount of air-entraining agents like glues or resin to create air bubbles in the concrete. This cement can withstand sulphate attacks. This method is utilized for increasing the cold resistance in cement, particularly when it is subjected to frequent freezing and thawing. The bubbles allow the space for contracting and expansion in cold climates to lower the risks of cracks and internal damage. It is not a high-strength cement and is designed for spatial use only.

There are Expansive Cements which grow in volume when blended in with water contrasted with ordinary Portland cement. By doing so, the cement aids in limiting the shrinkage loss caused because of loss of moisture. There are three sub-types of expansive cement, particular K-type, M-type, and S-type primarily used to bring down the risk of cracks in concrete constructions and

developments as well as pavements.

Expansive cement isn't recommended to use alongside fly ash and other pozzolans, as they can interfere with the expanding properties and strength. There are Coloured Cements because concrete isn't grey or white most of the time. With advancements in innovation, you can now find colored cement on the lookout. By blending 5 to 10% of mineral pigments into conventional cement, you can acquire beautiful colored cement like blue, green, yellow, and so forth. In the event that the pigment surpasses 10%, the strength of the cement is lost. Thus, the proportion is very important. These cements are utilized for creating decorative effect in flooring. Hydrographic Cement has water-repelling properties to keep away from the loss of cement in regions affected by frequent water contact obtained by blending customary Portland Clinker with Oleic acid or other water repellents to shape a thin film on the cement surface. Then there are Waterproof Cements or water-resisting cement has practically the same use as that of hydrographic cement. It falls under the hydraulic cement category. In many cases, the manufacturing process and the properties are different in both these cements. Waterproof cement is made by adding a water-repelling agent to normal Portland cement. Nonetheless, it isn't generally as watertight as hydro-graphic and may not be suitable for high water conditions.

They are utilized for waterproofing the terrace flooring, water tanks, and submerged sumps. Slag Cements are sorts of hydraulic cements that are prepared by finely crushing the granulated blast furnace slag (GGBFS). Nowadays, slag cement is utilized as an option in contrast to Portland cement for its better workability. It has a higher resistance and protection to chemical reactions and better compressive strengths. Likewise, adding slag cement to the standard concrete mixture can accelerate the setting time and give a superior completion. It is for the most part utilized in precast and ready-made cement and building structures that require high-temperature resistance. Then we have ultra-High Strength Cements (UHSG) as another variety of cement innovations, made as a feature of the new technological advancements. The cement is presently utilized as evolved in some countries, for making bridges and other massive structural designs. The ingredients utilized in this cement are Portland cement, Silica fume, Quartz flour, Superplasticizers, and organic or steel fibers. It is very sturdy in freeze-thaw conditions. They have extremely low chlorine permeability and high abrasive resistance contrasted with different types of cement.

6 . S U P P L E M E N T A R Y CEMENTING MATERIALS, SCMs

Supplementary cementing materials (SCMs) exhibit pozzolanic and/or cementitious properties and are used in concrete to partially replace the Portland cement component. SCMs differ in source, physical properties, and chemical composition. Examples of SCMs namely: fly ash (a by-product from coal combustion), slag cement (a by-product of the steel industry), silica fume (a by-product from elemental

silicon production), and metakaolin (produced from the calcination of kaolinite clay) are described here. Part of the motivation to incorporate SCMs in concrete stems from their potential to reduce greenhouse gas emissions, energy use, and waste disposal to landfill sites. Beyond these environmental benefits, the use of SCMs as a partial cement replacement can achieve similar or improved fresh mechanical, and transport properties compared to concrete without SCMs. Concrete containing fly ash, slag cement, silica fume, or metakaolin can improve the resistance to chloride ingress, alkali-silica reaction, freeze-thaw damage, and sulfate attack, compared to concrete without SCMs. However, concrete containing SCMs are typically more vulnerable to carbonation processes and can exhibit greater de-icer salt scaling mass loss than concrete without SCMs.

Supplementary cementing materials (SCMs) contribute to the properties of hardened concrete through hydraulic or pozzolanic activity. Typical examples are fly ashes, slag cement (ground, granulated blast-furnace slag), and silica fume. These can be used individually with portland or blended cement or in different combinations. Supplementary cementing materials are often added to concrete to make concrete mixtures more economical, reduce permeability, increase strength, or influence other concrete properties.

Fly ash (FA) is the most commonly used pozzolana in concrete. Commercially available fly ash is a finely divided residue that results from the combustion of pulverized coal and is carried from the combustion chamber of the furnace by exhaust gases.

Slag Cement, formerly referred to as

ferro-silicon alloys that is carried from the furnace by the exhaust gases. Silica fume, with or without fly ash or slag, is often used to make high-strength concrete.

Metakaolin is obtained from Kaolin clay, which is processed under carefully controlled conditions to refine its colour, remove inert



Figure 13: Green Substitutes to Cement known as supplementary cementitious materials (From the left to the right, class C fly ash, metakaolin (calcined clay), silica fume, class F fly ash, ground granulated blast furnace slag, and calcined shale)

ground, granulated blast-furnace slag, is a glassy, granular material formed when molten, iron blast-furnace slag is rapidly chilled - typically by water sprays or immersion in water - and subsequently ground to cement fineness. Slag cement is hydraulic

and can be added to cement as an SCM. Silica fume, also called condensed silica fume or microsilica, is a finely divided residue resulting from the production of elemental silicon or

impurities, and tailor particle size such that a much high degree of purity and

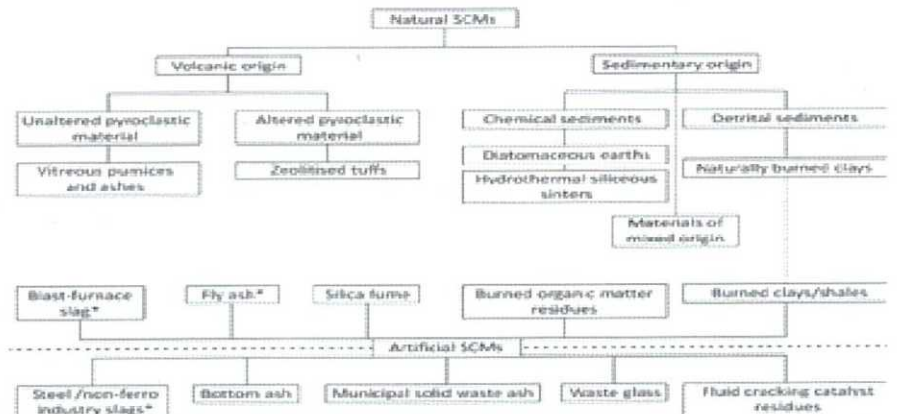


Figure 14: General classification scheme of supplementary cementitious materials. * denotes materials which can present hydraulic activity, all other materials display pozzolanic behavior. A selection of promising SCMs still largely under development are positioned below the dashed line

pozzolanic reactivity can be obtained. Superplasticizers may be used to aid dispersion for good workability.

GLOBAL SUPPLEMENTARY CEMENTITIOUS MATERIALS MARKET BY MATERIAL

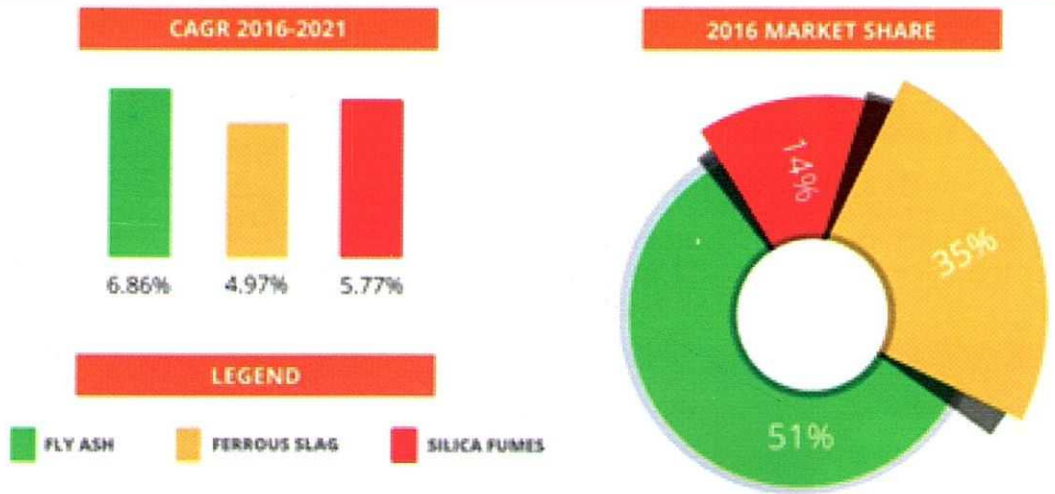


Figure 15: Global Supplementary Cementitious Materials Market Projected to be Worth USD 100.6 Billion in 2021



GGBS



Cement



Sand



Superplasticizer



Steel fiber-13 mm



Steel Fiber-16 mm



PVA fiber-6 mm



PVA fiber-12 mm



SFA-10- 12.5 mm

SFA- 12 to 18 mm

POS-10 to 12.5 mm

Silica Fume

Figure 16: Experimental Prognostication of Ultra-High-Performance Lightweight Hybrid Fiber-Reinforced Concrete by Using Sintered Fly Ash Aggregate, Palm Oil Shell Aggregate, and Supplementary Cementitious Materials

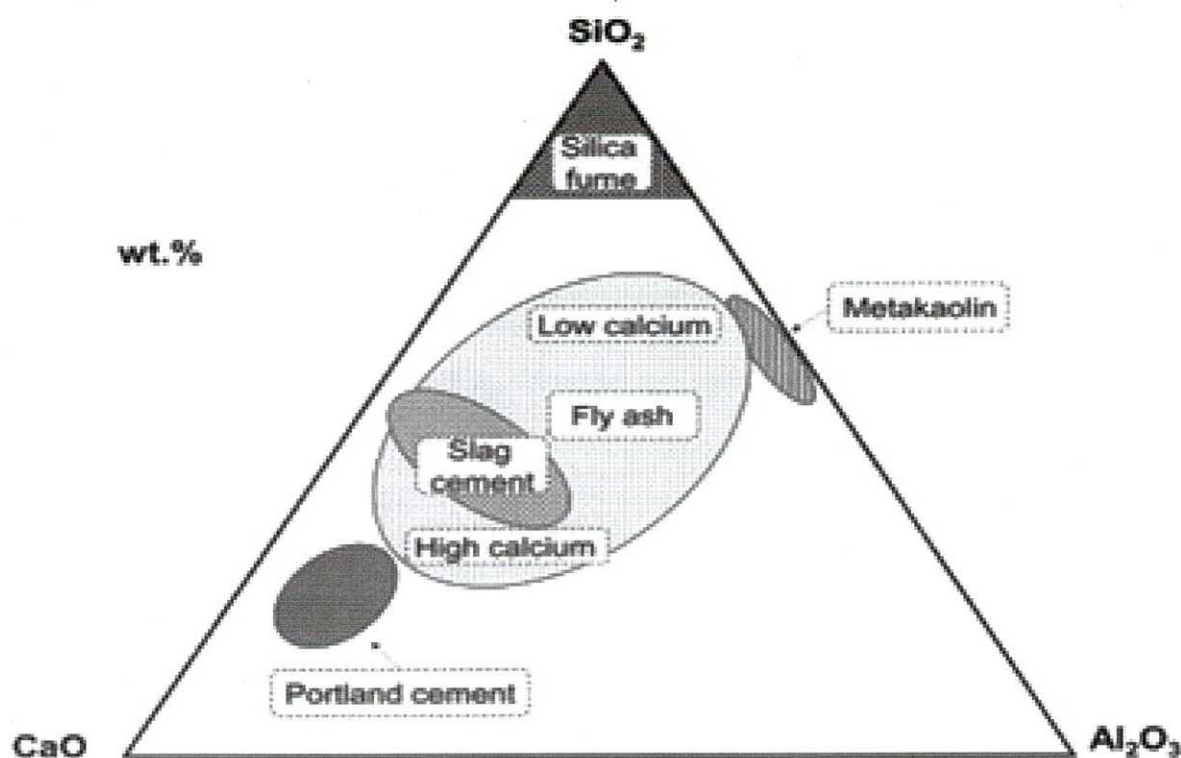


Figure 17: Triangular Placement of Cements by weight proportions

Supplementary cementitious materials

Derived from wastes	Derived from natural sources
Fly ash	Metakaolin
Slag	Calcined shale
Silica fume	Calcined clay
Rice husk ash	Volcanic ash
Corn cob ash	Zeolitic tuffs
Sawdust ash	Diatomaceous earth
Glass powder	Limestone
Bottom ash	
Cement kiln dust	

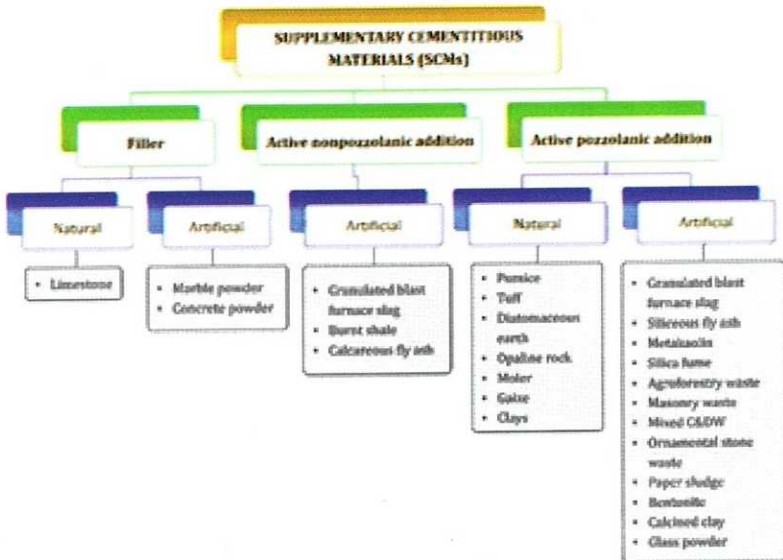


Figure 18: Further Details about SCMs

Many studies on these supplementary cementing materials have continuously been conducted by the author and many other researchers in Nigeria ready for application.

7. SUMMARY and CONCLUSION

7.1 Summary: Cement and Concrete are intertwined in the minds of many people, but so also are they truly so in actual fact. In another sense, we can assert that Concrete is the material that we interact with every day - in the structure of our homes, offices and hospitals, supporting our bridges and infrastructure, laid on our roads and pavements. Cement is the vital glue that binds the ingredients of concrete together and makes concrete the truly versatile and beautiful building material that is solving the needs of the world today and addressing the challenges of tomorrow. Cement's central use is to bind together the ingredients of concrete - sand and aggregates. Cement is a glue, acting as a hydraulic binder, meaning it hardens when water is added. Cement itself is a fine powder that is made by first crushing and then heating limestone or chalk, with a few other natural materials, including clay or shale, added. The ground base materials are heated in a rotating kiln to a

temperature of up to 1,450°C or as hot as volcanic lava. Indeed, cement in concrete has been fundamental in shaping our world because from the inherent benefits of concrete of strength, durability, resilience, safety and affordability to create vital infrastructure; be it road pavements and infrastructure like culverts, drainages, road barriers; bridges, railways especially the sleepers when steel ones are being pilfered; buildings as homes and offices; or the cities and even country homes we live in. What of sidewalks, tunnels, complex foundation structures, etc. Concrete is crucial for the transition towards global sustainable development and more generally for the infrastructure to support clean energy development. Concrete also plays a significant role in the energy efficiency of buildings. One of concrete's key assets is its versatility which means concrete can be used in a variety of ways to solve the many needs that individuals and societies have - shelter, housing, providing clean water and sanitation, transport, business and commerce. Concrete is an extremely strong, durable and resilient material. Looking back and now, Cement and Concrete have a long history of use in our world.

7.2 Plethora of Challenges: However, the cost of repairing, replacing and rehabilitating deteriorated infrastructures in Nigeria and across the world is becoming a major concern. The dire need to upgrade the structural capacity of our existing bridges and ageing infrastructure with modern and advanced building materials has been growing in popularity over the years. As illustration, Corrosion of reinforcement in concrete structures is a serious diffused deterioration phenomenon. Chloride attacking the carbonation of the concrete exterior is what leads to rebar corrosion and heavy maintenance requirements. Indeed, while concrete is a relatively convenient material to manage, however the construction industry has been dealing with a number of structural issues associated with cement concrete and concrete reinforcement. The rapid deterioration of many concrete infrastructures makes it difficult for the government to maintain or upgrade existing structures which would cost billions to trillions of naira every year to be effectively remediated. Intricately other demerits associated with its principal compound

cement makes the search for other binders both unavoidable and inevitable. Concrete itself is subject of cracking, disintegration, spalling, discoloration, scaling, curling, and crazing, being some of the common concrete problems. To complicate matters, infrastructure and buildings have been collapsing or failing with unacceptable frequency in Nigeria. Hence even though concrete remains one of the most popular materials in construction and is second only to water in terms of material consumption around the globe, however, drawbacks like the material's high carbon impact can make it unattractive for some projects. Shifting to its major compound, the cement industry is one of the leading producers of carbon dioxide. Growing consumer awareness of climate change and the environmental impact of construction has some clients looking for alternatives to materials that rely on cement. Therefore, scientists in the construction sector and the Built Environment have conducted researches and made growing range of cement and concrete alternatives available.

These materials provide similar benefits as concrete, like strength, durability, and longevity, but at a lower carbon cost, with less environmental impact, and often with an appealing and distinctive appearance. The 5C framework is structured around the key elements of the cement and concrete value chain: clinker, cement, concrete, construction and the built environment, and (re)carbonation.

For Climate solutions, the focus for cement and concrete industry, the key discussions target pathway to carbon neutrality. Thus researches have been initiated that aim to investigate and improve upon the materials' science and engineering of cement, cement composites, mortars, concrete and other allied materials that incorporate cement or other mineral binders. In doing so, we focus to obtain results and make breakthroughs on the properties and performance of cementitious materials; novel experimental techniques; the latest

analytical and modeling methods; the examination and the diagnosis of real cement and concrete structures; and the potential for improved materials.

7.3 Conclusion: Today as a consequence of diverse activities in research and applications, we do have options to both concrete and cement and even construction experts and organizations like NBRRI-Nigeria have engineered new construction materials, construction methods and techniques. Indeed, the emergence of numerous supplementary cementing materials including NBRRI Pozzolana Cement being produced in Bokkos and Ota are revolutionizing cement and concrete applications for potential lower cost construction and improved buildings and infrastructures. Research has introduced novel strategies for reducing CO₂ emissions in cement production, carbon sequestration into cement, the identification of new agents for enhancing durability, the development of ultra-high-performance concrete (UHPC) with

compressive strengths exceeding 170 MPa, radiation shielding, and the enhancement of the durability of concrete in extreme environments by employing mix designs. New classes of Cements have emerged and improvements are continually being introduced into the frontier of knowledge. Very importantly globally today is the influence of supplementary cementing materials, SCMs, especially fly ash, slag cement, silica fume, and metakaolin, though there are numerous others researched in

Nigeria and other parts of the globe. Part of the motivation to incorporate SCMs in concrete stems from their potential to reduce greenhouse gas emissions, energy use, and waste disposal to landfill sites; but one primary reason is economical to replace even partially Cement that has become so expensive. Thus supplementary cementing materials are often added to concrete to make concrete mixtures more economical, reduce permeability, increase strength, or influence other concrete properties.



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