TARA

नेपाल सिमेन्ट उत्पादक संघ
Cement Manufacturers Association of Nepal

MinErgy

LC³ Information Day in Nepal

Workshop
Proceedings

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LC³ Information Day in Nepal : Workshop Proceedings, 2023

For more information about LC³ project,
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Technology and Action for Rural Advancement (TARA) acts as the '**incubation engine**' of the Development Alternatives Group. The mandate of TARA, which was set up in 1985, is to test, adapt, and implement the innovations of Development Alternatives, a not-for-profit registered society. The main aim is to make the innovations market-ready for dissemination, primarily through social and commercial market channels. Over the years, it has disseminated various technologies in India and across the globe and incubated several business units. TARA has been nurturing new special purpose vehicles to take sustainable development solutions to scale. The clientele is today spread across entrepreneurs, enterprises along with national and multinational corporate groups.

Developed by: Bharti Jasrotia, TARA

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The event was organized by **Technology and Action for Rural Advancement (TARA)** in association with **Nepal Cement Manufacturers Association (NCMA)** and **MinErgy**, Kathmandu, Nepal

and

Indian Institute of Technology Delhi (IITD) and **Indian Institute of Technology Madras (IITM),** on behalf of LC³ Project Team in India.

Abstract

On 24th November 2022, Technology and Action for Rural Advancement (TARA), New Delhi in association with Indian Institute of Technology Delhi (IITD) and Indian Institute of Technology Madras (IITM) organized an LC³ Info Day at Hotel Radisson, Kathmandu. Nepal Cement Manufacturers Association (NCMA), MinErgy and Institute for Integrated Development Studies (IIDS) also partnered in the event for the region. The main objective of the Info Day was to communicate the technical, environmental, operational, and financial advantages of an innovative ternary cement made with a combination of clinker, limestone and calcined clays i.e. The Limestone Calcined Clay Cement (LC³). The event brought together various stakeholders to deliberate on the technical details of the new cement as well as clay feasibility studies done so far. With the participation of more than 70 officials from Department of Mines and Geology, Department of Industry, Nepal Bureau of Standards and Meteorology, Cement companies and other multi-laterals organizations, the event shared the progress

Left to Right:
Dr. Soumen Maity, Chief Technology Officer, TARA; Dr. Toya Narayan Gyawali, Secretary, Ministry of Industry, Commerce and Supply, Government of Nepal; Shri Dhruba Thapa, President, Nepal Cement Manufacturers Association; Ms. Silvana Hogg, Deputy Head of Mission, Embassy of Switzerland in Nepal; Prof. Shashank Bishnoi, IIT Delhi and Prof. Radhakrishna Pillai, IIT Madras.

Glimpse from Technical sessions

of LC^3 in India and other countries and explored the ways of how it can be adopted in Nepal.

Dr. Toya Narayan Gyawali, Secretary, Ministry of Industry, Commerce and Supplies, Govt. of Nepal graced the occasion as Chief Guest. The Guest of Honour, Ms. Silvana Hogg, Deputy Head of Mission, Embassy of Switzerland, Nepal, shared the role of Swiss Agency for Development and Cooperation (SDC) in supporting the research and dissemination of the technology. The inaugural session presented an overview of the status of Nepal Cement Industry and interest from Government sector to decarbonize the industry.

In subsequent sessions, resource persons from EPFL, IITD, IITM and TARA focussed on the development and applications of LC^3 sharing their global experiences with specific references to the Indian cement industry. Indian cement company i.e., JK Lakshmi Cements also shared the industry perceptive in actual implementation of the LC^3 in India. The technical session was followed by a round of discussion among the participants and speakers in which the fair motivation towards adoption of the technology was witnessed among government officials and cement industries.

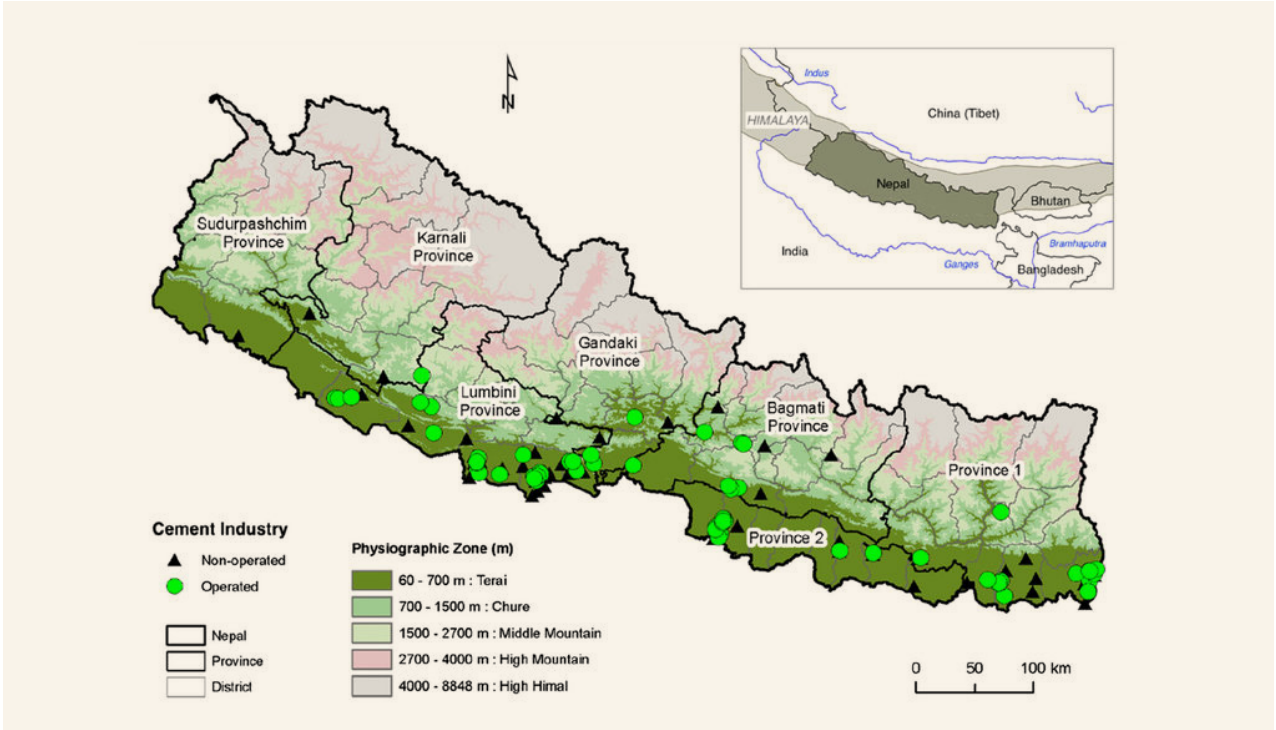
The major feedback given were towards initiating studies on finding out the availability of clays in Nepal and whether they will be suitable for commercial production of LC^3 in a profitable manner paving a pathway for adoption of LC^3 in Nepal. It was a unanimous decision that TARA should take the lead in undertaking the feasibility study with help and support from cement companies and NCMA. The Department of Mines and Geology, Government of Nepal spontaneously agreed to share all relevant data and support the feasibility study as well.

Background

The construction sector, contributing around 7% to GDP, is a major growth driver for Nepal. In the aftermath of April 2015 earthquake, the reconstruction activities escalated the demand for cement in the country. Moreover, as the country aims to achieve its sustainable development goals by 2030, massive construction activities can be expected in the coming years. The domestic annual demand for cement in Nepal increased from 4.54 million tons in 2014-15 to 4.81 million tons in 2015-16 and to 9.05 million tons in 2018-19.

The history of Nepalese cement industry started with the installation of Himal Cement Industries of 160 tpd in 1975. After some time, next unit of 200 tpd was added with the financial support of China. Similarly, two big plants; Hetauda Cement Industries Limited of 750 tpd and Udayapur Cement Industries Limited of 800 tpd were established. In 2002 the production at Himal Cement Industries was stopped due to the environmental issues. At present, more than 75 cement industries are registered with the Department of Industry, Nepal.

Map showing the location of cement plants in Nepal[1]



1. Thakuri, S., Khatri, S. B., & Thapa, S. (2021). Enflamed CO_2 emissions from cement production in Nepal. Environmental Science and Pollution Research, 28(48), 68762-68772.

Nature of Cement industry in Nepal

About half of the cement consumed in Nepal is Portland Pozzolana Cement (PPC), used in building construction to sewage pipes to dams. Ordinary Portland Cement (OPC) accounts for 40% of consumption and is used in building construction as well as for infrastructure like roads and bridges. Portland Slag Cement (PSC) accounts for 10% of consumption, and is used in building construction as well as pavements, foundations and certain large projects. Adding up the consumption of these three variants, industry estimates suggest that the market in Nepal was worth 133 billion Nepalese rupees ($1.2 billion) in 2018.

For the analysis of economic growth and demand of cement for Nepal, the study performed by Department of Industry, Government of Nepal in 2019, tried to establish the relationship between GDP growth and the growth of cement in Nepal. The results showed that if the GDP increases by one % the consumption or demand of the cement will increase by 4.78%.

Emissions and Cement demand

In Nepal, the estimated net CO_2 emission from cement production was 3.45 ± 0.50 mMt in 2019[1]. The process-related emission shares the highest emission during cement production, followed by combustion-related and electricity-related emissions. The emission from the process-related activity was 1.87 ± 0.16 mMt, combustion-related 1.52 ± 0.34 mMt, and 0.062 ± 0.004 mMt from the electricity in 2019. Nepal's cement industry shares 0.06% of the global CO_2 emissions from the cement

Figure: Map showing the location of cement plants in Nepal

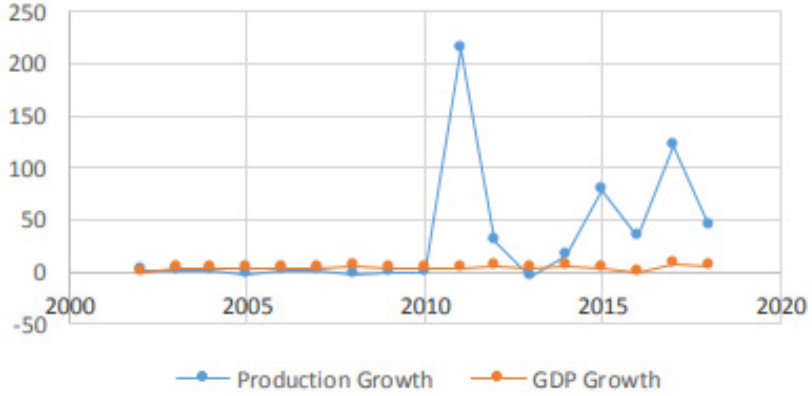
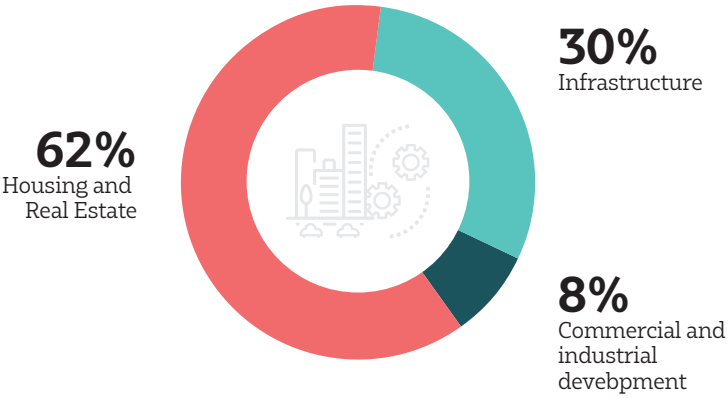


Figure: Cement demand from different sectors in Nepal



industry. To cater the reconstruction of work after the earthquake of 2015 and new infrastructure projects such development of 27 small towns, 13 smart cities and 5 Trans Himalayan city in various parts of the nation, the cement demand in Nepal is set to rise. Cement demand from these development work can be estimated to be around 5 million tons. In addition to this, National Planning Commission in Nepal has identified 22 national pride projects in line with the national vision of "Prosperous Nepal; Happy Nepali", which necessitates the investment in mega projects in physical and social overhead, and likely to raise the demand of cement within the country.

Also, in accordance with Nepal's Nationally Determined Contributions (NDC)[2], the country has announced to adopt low emission technologies in cement sectors to reduce coal consumption and air pollution, including thorough development and/or enactment of emission standards. On one hand, cement is the most used industrial commodity required for infrastructure development, but on the other hand, it is also responsible for high GHG emissions. Hence, there is a need to create a balance between infrastructure growth and maintaining environmental sustainability through emission reduction strategies deployed in the production and consumption of cement beyond energy efficiency. Therefore, switching traditional OPC with low carbon alternate materials like LC^3 can significantly reduce the emissions associated with OPC production.

2. "Second Nationally Determined Contribution (NDC)", 2020, Government of Nepal.

Highlights from
Inaugural Session

Introduction of Honourable guests and participants

In welcome address, Ms.Bharti Jasrotia from TARA welcomed the Honourable Chief Guest, Dr. Toya Narayan Gyawali, Secretary, Ministry of Industry, Commerce and Supplies, Government of Nepal, Guest of Honour- Ms. Silvana Hogg, Deputy Head of Mission, Swiss Embassy, Nepal, Shri. Dhruba Thapa, President, NCMA, Dr. Soumen Maity, Chief Technology Officer, TARA , Prof. Shashank Bishnoi, IITD, Prof. Radhakrishna Pillai, IITM and Government officials from various departments and other participants from cement companies and bi-lateral organizations.

"There is a huge potential to reduce carbon emissions from construction sector through this technology. Swiss Agency for Development and Cooperation (SDC) has supported LC³ for almost a decade, through Low Carbon Cement Project. It has high potential to reduce carbon emission from the cement sector."

– Ms. Hogg
Deputy Head of Mission, Swiss Embassy, Nepal

"Future cements will be based on Portland cement clinker with increasing levels of incorporation of SCMs. To avoid drastic climate change, we need to use cements with lower CO_2 emissions, i.e, LC³ Clinker/calcined clay/ limestone blends."

– Prof. Karen Scrivener,
EPFL

"The benefits of Limestone Calcined Clay Cement (LC^3) are supportive and instrumental for the Nepal Cement Industry and there is fare interest of Govt. of Nepal in taking this forward. The Department of Mines and Geology will provide all help and support for the introduction of LC^3 in Nepal."

- Dr. Toya Gyawali,
Secretary, Ministry of Industry, Commerce and Supplies, Govt. of Nepal

"LC^3 is a perfect example of how international collaboration can rapidly bring sustainable technologies from the laboratory to the market. The cement companies in Nepal are very much interested to adopt the technology and knowing the feasibility of kaolinitic clays. Formal request to TARA to undertake the feasibility studies to look at clay availability in Nepal."

– Shri. Dhruba Thapa,
President, NCMA

Highlights from
Technical Session

The technical session started with an informative presentation by Prof. Shashank Bishnoi, IIT Delhi on "LC^3 technology and standards", wherein the journey of research and application of LC^3 was shared. He added that it is commercially available in 5 countries and more than 25 countries in the world are preparing to produce it in coming years. In case of Nepal, there is very less availability of flyash and slag. Thus, calcined clay can be major raw material as SCMs for cement production. Moreover, Clay is calcined by heating to around 700–850 °C and since the calcination temperature is low, compared to clinker production, no sophisticated equipment is necessary to produce the calcined clays. It may be calcined in conventional rotary kilns, flash calcination units, fluidized bed, roller hearth kilns or even by static calcination in tunnel or shuttle kilns normally used in the ceramic/refractory industry. Adding to the technical details, he shared that when clay containing kaolinite is calcined, metakaolin is formed which is essentially an amorphous alumino silicate ($Al_2Si_2O_7$). This can react with calcium hydroxide as a conventional pozzolan to give C-(A)-S-H and aluminate hydrates. In addition, the alumina can react with the limestone to produce carbo-aluminate hydrates. All these products fill space and contribute to the development of properties (e.g., strength and durability) of cement. The reactivity of the calcined clay is overwhelmingly dependent on the kaolinite content of the clay. Clays containing about 40% kaolin or above give strengths comparable to plain Portland cement when used in LC^3 -50 (50% clinker, 30% calcined clay, 15% limestone and 5% gypsum). Such clays are widely distributed and, as clay is often one of the raw materials for cement production, may even be available in existing quarries of cement plants.

LC^3 is commercially available in 5 countries and will be available in 25 more countries in the coming years. Calcined clay can be a profitable substitute for fly ash in cement production to produce pozzolana cement.

LC³ is performs better than normally available cements especially in harsh environments.

LC³ will be a much better option for large scale construction subjected to very severe exposure conditions.

Following this, Prof. Radhakrishna, IIT Madras shared the presentation on "Performance of LC³ on concretes". The application of LC³ was shown to produce concrete that resists chloride penetration better than fly ash or slag. Due to the composition and small size of the pores in the LC³ based concrete, the same could be an ideal choice for harsh environment e.g sea, high humidity, extreme cold. He showcased the study for the use of LC³ in reinforced concrete structural elements of small shed within the facility of the Central Institute of Brackish water Aquaculture on the coast south of Chennai. The development of compressive strength and durability properties is being monitored at the structural site.

He shared another case study of "*Tetrapods for breakwater structure at the Kudankulam Nuclear Power Plant*" wherein Mix Design cement was used – 70% PPC and 30% LC² and concluded that LC² based concretes can be viable alternative for large scale construction subjected to very severe exposure conditions. He shared the studies of the robustness of the LC³ cementitious system for concrete application in comparison to OPC and widely used fly ash-based cement. Durability performance with respect to chloride, sulphate, carbonation and corrosion resistance was studied during the project. LC³ systems were found to have significantly improved performance with respect to chloride ingress, sulphate ingress and corrosion cracking. Carbonation resistance and chloride threshold for corrosion initiation were lower. The lower diffusion coefficient in LC³ ensure prolonged service life in chloride induced corrosion.

Dr. Soumen Maity in his presentation highlighted the cement production capacity of India, followed by the projected cement demand in the country. He added that there had been accelerated resource usage from the last two decades for buildings and construction sector. In FY 22, India was the second largest producer in the world, producing around 381 MioT of cement. He shared the projected scenario for fly ash generation, utilization, and availability in the cement production, which raised the concern of availability of fly ash for production of PPC in the coming years. It was pointed out that India will not have enough fly ash to produce pozzolana cement. This is bound to affect Nepal also since the country depends entirely on India for fly ash needs. It highlighted that the Kaolinitic clay is available abundantly in country, which can be utilised in the cement blended mix for cement production (LC³), to cater the projected cement

demand. It was also pointed out that during the started of the LC^3 project in India, there was a common belief amongst Indian cement industry that the country does not have any kaolinitic clay. Through resource studies by TARA, clay has been now identified in more than 26 states in India. Following this, the demand for similar clay feasibility studies in Nepal was highlighted by the audience, for adoption of low carbon cement technology.

Dr. S.K.Saxena (Sr. Vice Presient (Works), JK Lakshmi Cements Ltd. Sirohi) showcased the sustainability initiatives taken up by JK Lakshmi Cements, India, for augmenting the carbon neutral targets of JK Lakshmi Cements. It was shared that being one of the largest cement manufacturing companies in India, JKL has been focusing on the technology adaptation & upgradation and adoption of low carbon and low energy technologies to improve the CO_2 footprints of operation line. Jk Lakshmi cements has been emphasising upon the adoption of low carbon cement for decarbonising the sector. He shared that as a step towards adoption of low carbon technologies, a long-term MoU has been signed between JKLC (JK Lakshmi Cement, Sirohi) and TARA (Technology for Action and Rural Advancement). The MoU aims to develop and adopt low carbon technologies for JKLC to achieve their carbon neutrality target by 2047 through the production of Limestone Calcined Clay Cement (LC^3).

Kaolinitic clay is available in more than 26 states across India in large quantities suitable for use by the cement industries. Secondary literature survey shows the availability of clays in Nepal. However, this needs to be studied in detail and estimation of reserves needs to be made.

JK Lakshmi Ltd has aimed to achieve carbon neutrality in their cement production at Sirohi plant by 2047.

An MOU has been signed with TARA to work jointly towards achieving this target through the adoption of LC^3 technology in existing cement production.

After the presentations, there was a round of question answers followed by discussion with the participants. The main highlights of the discussion and was forward as suggested by majority of the participants were:

1. The immediate need is to conduct a feasibility study to find out whether there is suitable clay available in Nepal for LC^3 production. This is most important step. During the study it should also be identified where is this clay available, what is its quality and the approximate quantity of reserves. This will help the cement companies to take a decision in adoption of LC^3.

2. The discussion on the Indian standards for LC^3 was also initiated by the officials from Nepal Bureau of Standards and Meteorology (NBSM), wherein it was shared that the standards has been widely circulated by Bureau of Indian Standards (BIS) and will be made available within 2-3 months, so that the low carbon cement can be produced commercially by Indian cement companies. It was requested by NBSM to share the draft Indian standards for LC^3 so that preliminary studies can be done for its adoption.

3. Technical details on the performance, application and durability of LC^3 concretes will be shared with all the stakeholders including research publications to enable them to assess the quality vis-à-vis their current cement quality.

Following discussions, the event ended with a motivation to work in association with NCMA and government departments to introduce low carbon cement to the Nepal cement industries.

Way Forward

Cement production is markedly growing in developing countries including Nepal in recent decades. The cement production of Nepal was less than 500 kg per capita in 2020 and is estimated to double by 2025. In Nepal, reconstruction after the severe earthquake in 2015 has caused huge demand of cement . Moreover, as the country aims to achieve sustainable development goals by 2030, massive construction activities can be expected in the coming years. According to Nepal's Nationally Determined Contributions[2], the country has announced to adopt low emission technologies in cement sectors to reduce coal consumption and air pollution, including thorough development and/or enactment of emission standards.

The cement industry has a big role to play in the development of the nation in the years to come. On one hand, cement is the most used industrial commodity required for infrastructure development, but on the other hand, it is also responsible for high GHG emissions. Hence, there is a need to create a balance between infrastructure growth and maintaining environmental sustainability through emission reduction strategies deployed in the production and consumption of cement beyond energy efficiency.

Interest has been generated among the Government officials and cement companies towards switching traditional OPC with low carbon alternate materials like LC^3 which can significantly reduce the emissions associated with OPC production. The Information Day held on 24th November 2022 at Kathmandu proves to be the starting phase in Nepal for the adoption of low carbon cement. To facilitate it further, the study on the feasibility of Kaolinitic clay needs to be carried out for effective production of limestone-calcined clay-cement (LC^3) which appears to be quite promising from cost, energy and environmental perspectives.

Special Guests

Dr. Toya Narayan Gyawali	Secretary	Ministry of Industry, Commerce and Supplies, Govt.of Nepal
Ms. Silvana Hogg	Deputy Head of Mission	Embassy of Switzerland, Nepal
Shri. Dhruba Thapa	President	Nepal Cement Manufacturers Association (NCMA)

Resource Persons

Karen Scrivener	Professor	EPFL, Switzerland
Dr. Soumen Maity	Chief Technology Officer	TARA
Shashank Bishnoi	Professor	IIT Delhi
Radhakrishna Pillai	Professor	IIT Madras
Dr.S.K.Saxena	Sr.Vice President (Works)	JK Lakshmi Cements Ltd.
Dr.Bishnu Prasad	Director	Sarthak Concrete Pvt.Ltd.

Government Officials

Kushal N Pokhrel	Senior Divisional Geologist	Department of Mines and Geology
Narayan Banskota	Senior Divisional Geologist	Department of Mines and Geology
Shova Shing	Sr. Div. Geologist	Department of Mines and Geology
Dr. Suchita Srestha	Sr. Div. Geologist	Department of Mines and Geology
Antonia Flueck	Programme Manager First Secretary	Swiss Agency for Development and Cooperation, Nepal
Shiv Kumar Baokota	Senior Divisional geologist	Department of Mines and Geology Ministry of Industry, Commerce & Supplies, Govt. of Nepal
Dr.Sudhir Rajaure	Director General	Department of Mines and Geology Ministry of Industry, Commerce & Supplies, Govt. of Nepal
Alok Kumar	Director	NBSM
Shri Prabhat Kumar	Deputy Director General	Nepal Bureau of Standards and Meteorology (NBSM)
Tara Dutt Bhatt	Director	Nepal Bureau of Standards and Meteorology (NBSM)
Shri. Bishal Sapkota	Under Secretary	Ministry of Industry, Commerce and Supplies
Jyoti Joshi	DDG	NBSM

Cement Companies

Pankaj kumar	GM	Balaji Cement
Bhishnu Neupane	MD	Sarbottam Cement
Rajan Jha	Group Vice President	Advance Group
Bharat Dahal	CEO	United Cement
Nipesh Tayal	Managing Director	Sonapur Minerals & Oil Ltd.
Dr. Prasanna Man Srestha	Director	Cosmos Cement Industries Pvt. Ltd.
Uddhav Karki	General Manager	Arghakhanchi Cement

Raju Poudel	CEO	Arghakhanchi Cement
Bhartendu Tiwari	Operation Head	United Cement
Manohar Rajbhandari	Managing Director	MRB & Associates
Dr.Rajan Suwal	Chairperson	R&R Engineering Construction
K.P.Upreti	General Secretary	CMA
Janak Bahadur Chand	CEO	Dhaubadi Iron Company Ltd.

Other agencies

Binay Srestha	Sr. Engineer	Freelancer
Rabi Singh	President	Federation of Contractors' Associations of Nepal (FCAN)
Sampada Shrestha	Engineer	String Engineering
Kumar Khatiwade	ED	gdpnepal.com
Swarup Koney	Architect	Apniko Designer
Krishna		FIDA
Kshitiz Thapa	Director	Habitat Const. Eng. Pvt. Ltd.
Dr. P. Dangol	MD	ERTech
Prawal K. Khatri	T.A.	Kathmandu University
Rishi Koirala	CM	NVA
Dinesh	MD	3D Design Build
Kishore K. Jha	V.P.	Nepal Engineers' Association (NEA)
Bini Neupane	Student	Kathmandu University
Dr. Tara P. Pokhrel	Vice Chairman	CMA
A.D. Lama	Sr. V.President	FCAN
Dr.Kshitij Charan Shrestha	Assistant Professor, Civil Engg.	Institute of Engineering, Tribhuvan University
Bidya Banmali Pradhan	Senior Atmospheric Environment Specialist	International Centre for Integrated Mountain Development (ICIMOD)
Siva Praveen Puppala	Programme Coordinator	International Centre for Integrated Mountain Development (ICIMOD)
Dr. Bhupesh Adhikary	Senior Air Quality Specialist	International Centre for Integrated Mountain Development (ICIMOD)
Suyesh Prajapati	Managing Director	MinErgy
Dibya Acharya	Sr Architect	MinErgy
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Sangita Thapa Magar	Architect	SWN
Sarita Shilpakar		MinErgy

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Purna. N. Ranjitkar	Managing Editor	The Nepal Weekly
Krishna Adhikari	Editor	RSS
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Rajan Jha	Director	Space4K Television
Abdullah Miya		Kantipur Media Group
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TARA, New Delhi holds event to share progress of LC3

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Cement industry seeks support to boost demand, export

Modnath Dhakal Fri, 25 November 2022

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Kathmandu, Nov. 25: Citing the growing production and decreasing demands in the domestic market owing to the sluggish development and construction, President of Cement Manufacturers Association (CMA) of Nepal, Dhruba Thapa, has urged the government and stakeholders to create a favourable environment for increasing the export and consumption of cement.

The country's cement industry has an annual production capacity of 22 million tons while demand has gone down to 9 million tons a year last year. Industry estimates tell that the production capacity would rise to 25 tons a year by 2024.

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सिमेन्ट उद्योगका लागि एलसी 'थ्री' प्रविधि सस्तो र वातावरणमैत्रीः विज्ञ

नेपाल पूर्वाधार

काठमाडौं । विश्वका विभिन्न मुलुकसहित छिमेकी भारतमा समेत उपयोगमा आइसकेको एलसी 'थ्री' (लाइमस्टोन क्यालसाइन्डक्ले सिमेन्ट) प्रविधि नेपालका सिमेन्ट उद्योगहरूका लागि पनि उपयोगी हुने विज्ञहरूले बताएका छन् । एलसी 'थ्री' प्रविधिबारे जानकारी दिन राजधानीमा आयोजना गरिएको कार्यक्रममा सहभागीहरूले लागतका हिसाबले सस्तो र कम कार्बन उत्सर्जन हुने हुँदा नेपालका सिमेन्ट उद्योगहरूका लागि यो प्रविधि उपयुक्त हुने बताएका हुन् ।

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