Dr. Shailesh Kr. Agrawal
Executive Director
Building Materials & Technology Promotion Council (BMTPC)
(Ministry of Housing & Urban Affairs, Government of India)

Resource optimization in building material sector is key to sustainable development.

Seismic Academy: Walk us through your vision of Indian Infrastructure 2025 for the building material industry.

Dr. Shailesh Kr. Agrawal: In the wake of climate change & global commitments to bring down GHG emissions & march towards net zero sustainable development, it is high time, we take a leap from conventional construction practices & transit towards resource-efficient, climate-responsive, energy-efficient disaster-resilient materials, processes, systems & technologies. Cast-in-situ masonry/RCC construction using brick by brick/brick & sticks is being replaced globally by offsite construction wherein building elements can be produced under controlled conditions in a factory setup or casting yard and transported to the site for assembly & making the desired structure. These industrialized building systems are time-tested & proven around the globe & being practiced in the country also. The Indian construction industry is picking these practices slowly but surely. Therefore, Industrialized building systems are the future of Indian Infrastructure.

Also, to be developed nation by 2047, the rapid construction systems which reduce the construction time considerably are imperative & will replace the existing RCC framed construction. As regards materials, cement & steel are major ingredients of any construction but these materials are based on finite natural resources and therefore to be used optimally. Resource optimization in building material sector is key to sustainable development. Cement blended with supplementary cementitious materials (SCM) such as fly-ash, slag, GGBFS; materials based on renewable resources, waste, by-products; recycled/refurbished materials; green concrete, geo-polymer concrete; geo-polymer coarse aggregates; fly-ash to sand; nano concrete aggregates; artificial sintered aggregates; manufactured sand; slag sand; FRP/GFRP steel bars, fibres replacing rebars are few in the future list of materials. Smart materials, materials with less embodied energy & eco-labelling of materials is the vision for futuristic materials.

Seismic Academy: What all, in your opinion, have been paradigm shifting practices incorporated in India's New Age construction processes?

Dr. Shailesh Kr. Agrawal: Govt. of India through Ministry of Housing & Urban Affairs conducted Global Housing Technology Challenge-India (GHTC-India) to transplant globally available proven best construction practices to India in 2019 & this challenge has been the trailblazer in triggering the technology transition in the construction sector. I must urge readers to go through our website https://ghtc-india.gov.in & know it all about the India's New Age construction systems being promoted by us & concerted efforts are made to create enabling eco-systems to mainstream them. We have created a basket of 54 futuristic technologies for stake holders to pick & choose as per geo-climatic conditions & cost/time constraints. CPWD has issued SORs for most of them & also published a detailed circular on their applicability. However, for the sake of readers, let me explain you these systems briefly. The 54 technologies are divided into 6 broad categories namely

- Precast Concrete Construction System - 3D Precast volumetric: a system where 3D RCC modules/ PODs are cast & transported to the site for assembly
- Precast Concrete Construction System - Precast components assembled at site: Planar RCC building components such as walls, slabs, staircases, sun-shades, facades, beams, columns are cast offsite & assembled at site.

- Light Gauge Steel Structural System & Pre-engineered Steel Structural System: Steel frame comprising of hot rolled steel sections or cold-form(light-gauge) steel frames along with different infill options
- Prefabricated Sandwich Panel System: Dry wall construction replacing conventional masonry walls. These Sandwich panels comprise of lighter core material sandwiched between two outer wythes/sheathings & can be used for load-bearing/non-load bearing applications
- Monolithic Concrete Construction: Customized formwork systems which allow casting of walls & floors together thereby enabling robust monolithic construction. Also known as Aluminum form work systems. Some form works use steel also as form work material such as tunnel form work
- Stay-in-Place Formwork System: It is lost or sacrificial form work which is left in the structure to act as part of the structure. There are PVC wall forms which are prefinished walls & can be erected directly

Under PMAY-U, these six systems are being demonstrated by constructing six Light House Projects (LHPs) consisting of 1000+ houses each at six locations namely Chennai, Ranchi, Indore, Rajkot, Lucknow & Agartala. These LHPs are projected as live laboratories for stakeholders to learn & emulate. There are other recent developments such as 3D printing, cloud-based project monitoring, block-chain construction management, construction using robots. Construction 4.0 i.e. digital transformation in the sector is next major revolution.

“Embark on India’s construction revolution with the GHTC-India by the Ministry of Housing & Urban Affairs. Explore 54 futuristic technologies for sustainable building solutions.”

Seismic Academy: What are BMTPC’s offerings in terms of skill development, disseminating material awareness and creating environment for innovative technologies to the construction industry?

Dr. Shailesh Kr. Agrawal: In order to have an integrated approach for comprehensive technical & financial evaluation of emerging and proven building materials & technologies, their standardisation, developing specifications and code of practices, evolving necessary tendering process, capacity building and creating appropriate delivery mechanism, Ministry of Housing & Urban Affairs, Government of India has set up a Technology Sub-Mission under PMAY-U with the Mission statement as Sustainable Technological Solutions for Faster & Cost Effective Construction of Houses suiting to Geo-Climatic and Hazard Conditions of the Country.

The Technology Sub-Mission facilitates (a) adoption of modern, innovative and green technologies and building material for faster and quality construction of houses (b) preparation and adoption of layout designs and building plans suitable for various geo-climatic zones (c) assisting States/Cities in deploying disaster resistant and environment friendly technologies.

BMTPC is mandated to identify, evaluate and promote emerging construction systems suiting to different geo-climatic conditions of the country, which are safe, sustainable and environment-friendly and ensure faster delivery of quality houses. The Government of India has authorized BMTPC to certify such new systems through Performance Appraisal Certification Scheme (PACS) (vide Gazette Notification No. I-16011/5/99 H-II Vol 49 dated 4th December, 1999). The third edition of Compendium of Prospective Emerging Technologies for Mass Housing has been published and can be downloaded from www.bmtpc.org.

In order to facilitate adoption of alternate and emerging technologies by the State Governments, Ministry of Housing & Urban Affairs has pursued CPWD, BIS and State departments to come out with

notifications, Circulars, SORs, specifications etc. which will authorize State governments to use these new construction technologies in housing projects.

For better advocacy & wider dissemination & also to showcase the field application of innovations in the construction sector technologies, MoHUA has taken an initiative to construct Demonstration Housing Projects (DPHPs) across the country through BMTPC. These DHPs are also used to impart hands-on training to professionals & artisans during construction.

To build capacities of engineers & architects, MoHUA is also running an online Certificate Course on Use of Innovative Construction Technologies "NAVARITIH" in collaboration with BMTPC & School of Planning & Architecture, New Delhi (https://ict.bmtpc.org).

In order to catalyze the market for affordable housing, MoHUA has been encouraging State Governments and large public agencies like housing boards, railways, defence and public sector units to undertake construction of their projects using innovative technologies.

Seismic Academy: Precast construction is gradually gaining prominence in India. How would you evaluate the performance of precast structures in the event of moderate to severe earthquakes. Given India as a country is fairly prone to these tremors?

Dr. Shailesh Kr. Agrawal: First of all, it is a misconception that Precast concrete construction will not perform better than conventional construction during shaking of ground. A few structures fell during earthquakes but since then we have acquired more know-how, learnt lessons & conducted experimental & analytical investigations to supplement performance based precast concrete construction. Nevertheless, we have not allowed precast concrete construction in Zone V in India which is the most severe earthquake zone. Also, full scale testing of protype structures using innovative technologies is being encouraged to study seismic behaviour of buildings being bult in Indian context & to gain further insights. BIS has also come out with brand new comprehensive codes on precast construction along with ICI precast handbook which help design & construct such buildings. CPWD has also recommended use of precast construction up to Zone IV.

> **"Full scale testing of protype structures using innovative technologies is being encouraged to study seismic behaviour of buildings being bult in Indian context & to gain further insights."**

Seismic Academy: What specific projects or programs has BMTPC undertaken to introduce and implement advanced technologies aimed at improving earthquake resilience in the country?

Dr. Shailesh Kr. Agrawal: India has a history of disasters leading to irretrievable losses to lives and properties on account to its geological settings and distinct demography. Realizing the need, there have been concerted efforts made by Government of India to bring paradigm shift in its approach towards disaster risk reduction. The traditional 3 Rs (Rescue, Relief & Restoration) are now replaced by 3 Ps (Prevention, Preparedness & Proofing) and pro-active pre-disaster preventive measures are part and parcel of India's growth story. Some of the watershed moments in the annals of disaster management in India are enactment of Disaster Management Act, formulation of Disaster Management Policy and National Disaster Management Plan which are in line with UN resolutions, Hyogo framework (2005-15), Sendai framework (2015-2030) on natural disaster reduction and sustainable development goals. One of the major contributions of BMTPC i.e., bringing out Vulnerability Atlas of India which till date is the only document existing on damage risk to existing housing stock in India w.r.t. natural hazards e.g. earthquake, wind & cyclone and flood. The atlas was first published way back in 1997, and then in 2006, 2008 (CD form) based on 2001 Census data and then third edition of the Vulnerability Atlas of India was brought out in 2019 updated based on updated recent available data from IMD, Survey of

India, Geological Survey of India (GSI) and Census 2011. It includes hazard maps of earthquakes, wind/cyclones, floods, landslides, thunderstorms and vulnerability risk tables based on available latest data in order to help in enhancing preparedness of Governments and various other agencies in mitigating natural disasters. The Atlas is a useful tool not only for public but also for urban managers and National & State Authorities dealing with disaster mitigation and management.

Seismic retrofitting of existing vulnerable buildings is one of the most challenging tasks before the architects & structural engineering fraternity. A large number of existing buildings in earthquake prone areas over the world need seismic retrofitting due to various reasons & motivations, including codal modifications, deterioration of structures with age or change in use or modification of structure. Earthquake damaged buildings may also need retrofitting along with repair of damaged portion for reuse. Seismic retrofitting of existing stock is one of the most effective methods towards seismic risk reduction in future & to have safe & better habitat. In its efforts to demonstrate the retrofitting techniques for seismic strengthening, BMTPC undertook the retrofitting of few MCD school buildings & life line buildings so that the awareness could be generated among the stakeholders as well as various government agencies about the need and techniques of retrofitting. The experience on these buildings would help people at large and the policy makers in working towards reducing the vulnerability of lakhs of existing buildings through retrofitting of public and private buildings.

Seismic retrofitting of existing stock is one of the most effective methods towards seismic risk reduction in future & to have safe & better habitat.

Seismic Academy: Please throw some light on the regulatory policies which the government is planning to ensure sustainable construction practices, both in terms of structural resilience as well in terms of overall sustainability.

Dr. Shailesh Kr. Agrawal: India is witnessing rapid urbanisation with about 377 million people comprising 31.14% of the total population lived in urban areas (Census 2011). The urban population is projected to grow to about 600 million by 2031. While cities are engines of growth, they also contribute to more than 70% of India's greenhouse gas (GHG) emissions leading to extreme weather events.
India is witnessing perceptible increase in number as well as intensity of extreme weather events in recent times. India has unique geo-climatic and socio-economic conditions, and is vulnerable, in varying degrees, to rising sea levels, floods, droughts, cyclones, landslides, avalanches, storms, and heat waves. It is estimated that India will experience a decline of about 2-6% in its GDP under the carbon-intensive scenario by 2050, which could pose a serious threat to its development goals and investments. India is committed to reduce its emissions by 2030 up to 45% & become carbon neutral by 2070. Therefore, sustainable habitat is need of the hour.

National Mission on Sustainable Habitat 2021-2030 is in place. The excerpts from the mission document are reproduced here. Sustainable Habitat is an approach towards a balanced and sustainable development of the ecosystem of habitat which offers adequate shelter with basic services, infrastructure, livelihood opportunities along with environmental and socio-economic safety including equality, inclusiveness and disaster-resilience. It can be broadly divided into five areas, namely
(i) Energy and Green Building: It focuses on reducing the energy consumption for HVAC, etc. in India's real estate sector and shifting to cleaner renewable energy sources through adoption of green building technologies.
(ii) Urban Planning, Green Cover and Biodiversity: It lays emphasis on integrated urban and regional planning approaches to climate-sensitive development and preservation and rejuvenation of water bodies, green spaces, and eco-sensitive areas.
(iii) Mobility and Air Quality: focuses on inclusive and multi-modal mobility options in order to arrest the

rapid growth of private motor vehicles, which has led to traffic congestion and increasing air pollution levels in metro cities. (iv) Water Management: lays emphasis on augmenting existing water resources by adopting rain-water harvesting (RWH), rejuvenation of waterbodies, recycling/ reuse of treated sewage, water conservation, and promoting circular economy of water. and (v) Waste Management: focuses on the need for cities to prioritise actions for waste reduction and waste management, and promote waste-to-energy and waste-to-compost plants.

In 2024, we will also have Eco-Niwas Samhita (ENS) 2024 (Energy Conservation and Sustainable Building Code) for Residential, Commercial & office Buildings. Note, the word sustainable has been added in the erstwhile ECBC code of 2018.

As regards Disaster risk reduction, there have been several policy documents in forms of act, policy, plan, Techno-Legal Regime & building bye-laws. Ministry has published Model Building Bye-Laws-2016 (MBBL-2016) for the guidance of the State Governments, Urban Local Bodies, Urban Development Authorities. Building Bye-Laws are legal tools used to regulate design and construction aspects of buildings. They are mandatory in nature and serve to protect buildings against fire, earthquake, noise, structural failures and other hazards. As regards, safety & security, the chapter 6 of MBBL is on provisions for structural safety which includes Structural Safety, Disaster management as per late Prof. Arya Committee Report and BIS Codes including Structural Design Basis Report (SDBR) for various building types, seismic strengthening/retrofitting & prevention measures against Soft Storeys in multi-storeyed buildings and Proof Checking of Structural Design for buildings.

“India is committed to reduce its emissions by 2030 up to 45% & become carbon neutral by 2070. Therefore, sustainable habitat is need of the hour.”

Seismic Academy: BMTPC’s collaboration with NIDM and NDMA for disaster management is widely known. How do you foresee the association with Seismic Academy also, in this regard to ensure we reach greater section of the fraternity? What is your recommendation for Seismic Academy going forward?

Dr. Shailesh Kr. Agrawal: In today context, when we have reached to a point where enough literature & data is available with regard to seismic design, construction & other related topics, it is time to reach out to the people & get it translated in the field in letter & spirit. Seismic Academy can play a crucial role in spreading awareness, building capacities, educating professionals & artisans & can take up demonstration projects to showcase cutting edge materials & technologies to enhance disaster resilience. Information, Education, and Communication (IEC) can play a pivotal role in empowering communities with knowledge and skills to improve resilience of the society. Seismic Academy can delve into the significance of IEC in community development, emphasizing its role in promoting awareness, fostering participation, and catalyzing sustainable change.

Seismic Academy: Any key message for the students and young practicing engineers?

Dr. Shailesh Kr. Agrawal: As per clarion call given by our Hon’ble PM, let us contribute towards nation’s growth & take our country towards developed nation by 2047 in a most positive & befitting manner to best of our capabilities. India is cruising to become $5 trillion economy & world’s third largest. The construction sector in India is emerging as third largest sector globally & reached $ 750 billion in value. It is therefore obligatory upon us to be Receptive, Innovative and Productive to foster sustainable growth and ensure better quality of living. For fellow citizens.