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Accelerating urban action for a carbon-free world

World Habitat Day

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Accelerating Urban Action for a Carbon-Free World

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निर्माण सामग्री एवं प्रौद्योगिकी संवर्द्धन परिषद्
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BUILDING MATERIALS & TECHNOLOGY PROMOTION COUNCIL
Ministry of Housing & Urban Affairs, Government of India

"Creating Enabling Environment for Affordable Housing for All"

Enhancing Thermal Comfort in buildings through Innovative Construction Technologies and Materials



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Buildings are and continue to be responsible for consuming a major portion of energy that is produced in the world. According to the latest estimates from the UN environment[1], the energy consumption by buildings and constructions in 2019 globally stood at 35 per cent (with 38 per cent associated CO_2 emissions), accounting for the largest share of final energy use. Lowering of energy and emissions intensity of this sector and implementing focused strategies on materials to reduce life-cycle carbon emissions is recognized to be the most cost-effective way of combating climate change.

Nearly 95 percent of the housing shortage in India is in the lower income categories. PMAY-U (Pradhan Mantri Awas Yojna-Urban), government of India's flagship program for affordable housing for all in the urban and rural areas, is set to address the deficit by adding 11.3 million new housing. As these houses will be operational for at-least 50-60 years, this will not only have a bearing on the energy demand from the residential sector but also require huge quantities of building materials, putting tremendous pressure on our natural reserves.

The problem is twofold – the increase in residential floor space would lead to a 5 fold increase in electricity demand by 2032[2], as a significant percentage of Indian households will be living in thermally uncomfortable dwelling[3], therefore relying on mechanical means of cooling. Additionally, it will also put a burden on its already dwindling natural resources needed for construction. The current policies are focusing largely on the speed, ease, and cost of construction in utilizing new construction technologies and materials. This is a tremendous opportunity to mainstream energy efficiency and environmental sustainability in these housing projects, particularly in the affordable housing sector to provide thermally comfortable housing through passive means.

Construction materials used in Indian housing have mostly been dominated by conventional materials like solid burnt clay bricks. From villages to cities, clay bricks are easily available and provide a sturdy and cheap building material for all income groups in India. However, the environmental costs associated with this material is high. From the initial stages of procurement of soil (which is mostly the most fertile topsoil), to the energy intensive process of baking in brick kilns to higher energy costs during building operations.

Building envelope made from conventional materials (such as clay bricks) are responsible for extensive heat gains and losses in a building due to poor insulating properties (U-value) of the material which is unable to provide indoor temperatures within acceptable thermal comfort levels. These material choices end up having a large implication on the consumer's choice for opting for mechanical cooling, increasing operational energy, which in turn affects the long term affordability of the occupants.

However, over the years there has been an increase in the availability of alternate building materials and technologies and several private players have entered the market. Many states are already utilizing alternate building techniques like monolithic concrete construction system and pre-cast

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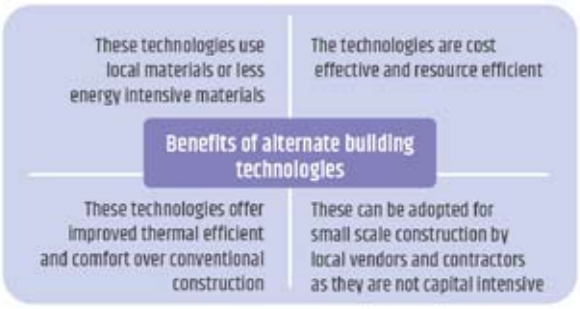
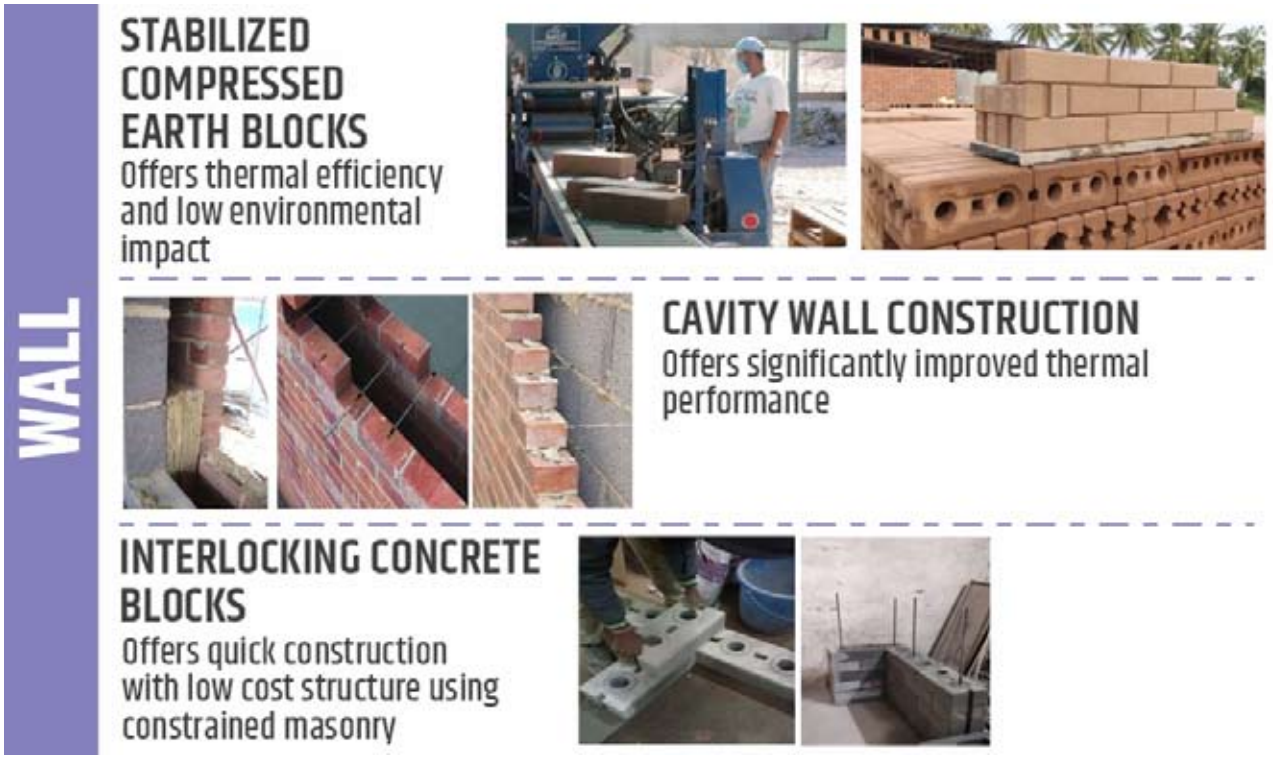


concrete. But these choices have predominantly been motivated due to their speed and ease of construction and do not consider energy efficiency, thermal comfort, and environmental sustainability as a guiding criterion.

Several new age building materials and walling assemblies are now available which provide better insulation (lower U-values) and can help in maintaining acceptable thermal comfort levels throughout the year besides performing well on other criteria such as strength, resistance to fire, water resistance, stability, etc. The Building Materials and Technology Promotion Council (BMTPC) has recognized some of these walling assemblies and technologies which have demonstrated acceptable structural and functional performance. These materials and technologies are currently being utilized in various Light house Projects (LHP) and Demonstrations Housing Projects (DHP) being executed in different states of India, to showcase their performance and demonstrate innovative construction methodologies.

A scoping study[4] conducted in a pilot affordable housing project in Telangana established that replacement with several of these new age materials and walling assemblies in a high-rise apartment building led to acceptable RETV values (acceptable heat gains) as prescribed by the building energy code for residential buildings (ECBC-R or Eco-Niwas Samhita 2018), as opposed to the base case scenario (made from fly ash concrete blocks) which had higher heat gains. Building materials such as AAC blocks and stay in place formwork systems utilizing EPS (Expanded Polystyrene insulation) based insulation lowered the heat gains to acceptable limits due to their superior insulating properties and led to higher number of thermally comfortable hours annually. This makes a case for the importance of proper selection of walling materials and the need for building performance studies in the early stages of the project.

Material selection for affordable and sustainable housing is not just limited to energy efficiency and thermal comfort. Their impact is multifaceted and affects embodied energies and associated environmental impact due to extraction, production and transportation. Therefore, these considerations along with their reusability and recyclability must also become deciding factors for evaluating the performance of building materials and new technologies, on the principles of circular economy. Currently, Construction and De-



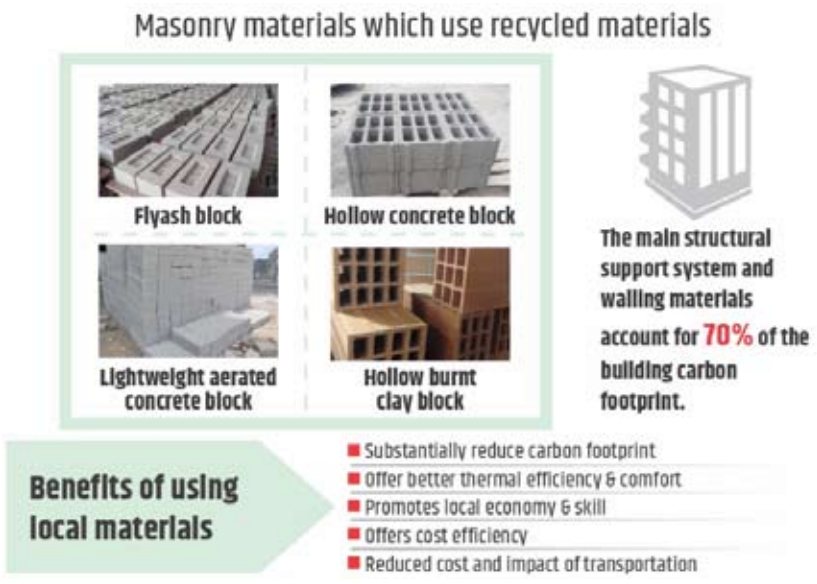
molition (C&D) waste management rules 2016 mandates utilization of recycled C&D waste in public projects, however the assessment of such products in terms of energy efficiency and thermal comfort is still in a nascent stage.

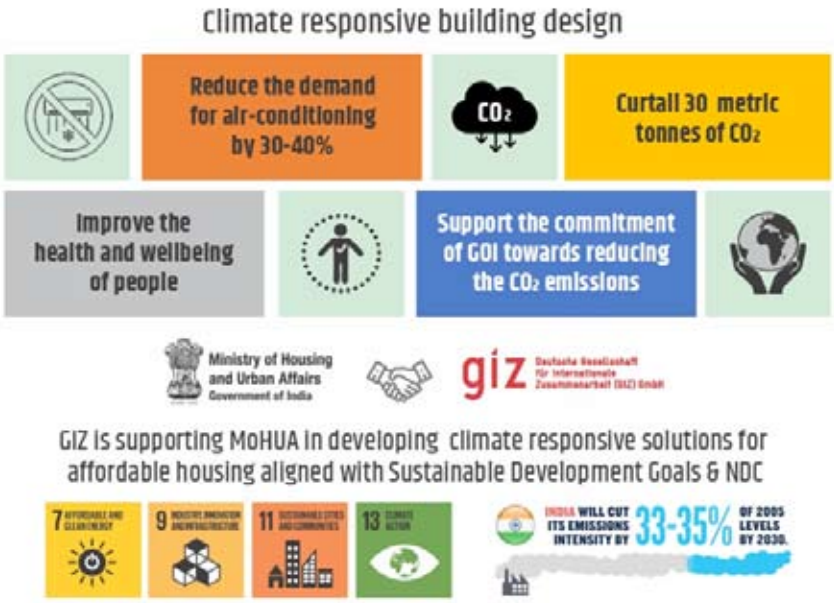
The policy mandate as prescribed by ECBC-R makes it clear that achieving energy efficiency is an interplay between material choices and building design and both must be carefully analyzed and evaluated to achieve the desired goal. Policy mandate to design for energy efficiency are now available in the form of ECBC-R and NBC (National Building Code), 2016. Since most affordable housing projects are naturally ventilated or mixed mode, developing specific thermal comfort standards for affordable housing projects for different climatic zones of India can initiate adoption of native materials and tailored passive design strategies for construction in each climatic zone.

India is aggressively building affordable housing and promoting new materials and technologies. Therefore, it is imperative to evaluate them on multifaceted criteria of energy efficiency, thermal comfort, and resource efficiency and to make sure right materials and designs that are responsive to native climate are used. New materials such as AAC blocks and fly ash bricks have become increasingly popular for construction in India and are made from byproducts of other industries besides having potential for recyclability.

India currently has in place energy conservation building codes for both commercial and residential buildings which are addressing efficient building constructions by bringing down the cooling requirements of buildings through both passive and active means. Affordable housing projects that are to be build will not only be required to be sustainable, but also must provide thermal comfort through passive means, which may otherwise affect the affordability of the occupants in the long term due to high electricity costs for cooling and heating. Therefore, the transition in the affordable housing sector to provide thermal comfort and energy efficiency require a road map in the form of Thermal Comfort action plan which will be a guideline for policy makers and implementers such as Ministry of Housing and Urban Affairs (MoHUA), BMTPC, State Agencies, Central Public Works Department (CPWD) & State PWDs, State Urban Development Ministries, and ULBs etc. The development of the Thermal Comfort action plan for affordable housing must put to use a multifaceted approach, aiming at significantly reducing the discomfort hours compared to typical design conditions and recommend strategies that integrates technologies (low cost, rapid construction, local raw materials based), sustainability, embodied energy, and advance building materials relevant for affordable housing.

Currently, the Adaptive Thermal Comfort model in National Buildings Code 2016 provides thermal comfort ranges for naturally ventilated buildings, air-conditioned buildings and mixed-mode buildings. Requirements for passive construction and material specifications suitable for the Indian contexts for enhancing the thermal comfort level in affordable housing for different climatic zones of India can be supplemented by creating a Thermal Comfort standard. Many international standards on thermal comfort like ASHRAE 55, ISO 07730, CEN EN 16798 etc. can be used to build upon and inform the development of the standard. The proposed outcome of the standard must be directly linked to the thermal comfort level and corresponding improvement in thermal comfort level and be complimentary to other national standards like NBC 2016, Eco Niwas Samhita, ISHRAE IEQ, Model building bye law 2016 etc. The new standard should be able to fill in the gap in contrast to the existing standards, codes under





implementation under the Indian scenario as compared with standards and codes available around the world.

Feedback from the relevant stakeholders and the challenges faced by states in implementing affordable housing will identify critical issues and gaps in adapting the standard for affordable housing in five climatic zones, especially the issues related to building materials (viz. building envelope), natural ventilation and mixed mode ventilation. The standard thus will provide quantifiable thermal comfort performance for various passive and active strategies based on the existing literature, gap analysis, and typology studies and modelling studies with the feedback from the relevant stakeholders incorporated.

The thermal comfort action plan and standard for affordable housing will provide the necessary environment to transform the current construction practices and help in mainstreaming of alternate materials and technologies that perform well in terms of thermal comfort, energy efficiency and environmental sustainability. These innovative materials, along with building designs, can form the backbone for coming up with ready to use passive and active design construction measures and guidelines which will facilitate in the implementation of the standard and help in achieving goals as envisaged in the Thermal comfort Action Plan for affordable housing. These guidelines therefore will become a one stop shop for primary users like developers, builders, building contractors who will be able to utilize this knowledge on ground.

GIZ on behalf of The Federal Ministry of Economic Cooperation and Development (BMZ), Germany, and in cooperation with the Ministry of Housing and Urban Affairs (MoHUA), Government of India aims to foster sustainability in built environment in order to use sustainable materials for Thermal comfort and in turn improve the environment and climate conditions. Currently, it is providing technical assistance in developing thermal comfort action plan for climate resilience building for mass scale application in selected states for Affordable Housing and the implementation of the Global Housing Technology Challenge India (GHTC-India).

Endnotes:

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