Need for the comprehensive sustainable building byelaw regulations to promote carbon neutrality in Indian cities.

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Abstract:

As buildings emit approximately 1/3 of all Greenhouse gas (GHG) emissions and produce up to 40% of annual solid waste, sustainable building byelaw regulations play a significant role in creating a carbon-neutral built environment. They set the regulatory framework that encourages or mandates practices to reduce carbon emissions across the lifecycle of buildings. Incorporating the green building strategies into building byelaw regulations encourages the development of energy-efficient, resilient, and low-carbon sustainable forms. Regular byelaw revisions, integration of renewable energies, promotion of eco-friendly materials, and providing incentives for constructing green buildings and sustainable built forms can drive urban centers toward carbon neutrality and illustrate how adaptable, context-specific regulations can support a future-oriented, sustainable built environment. In addition to it, sustainable building byelaw regulations plays a significant role in creating a carbon-neutral built environment. They set the regulatory framework that encourages or mandates practices to reduce carbon emissions across the lifecycle of building to Sustainable and climatic responsive architecture contributes to minimizing the depletion of the natural resources such as ground cover, forests, and water. This paper discusses the exclusive need for a comprehensive sustainable guideline for built environment for most of the Indian cities with few strong references from various research papers, National building code (NBC) -2016, Energy Efficient Building Code (ECBC), Bureau of Indian Standards (BIS) for natural daylighting and existing regulatory incentives provided by various authorities from Indian cities.

Keywords:
Sustainable Building Byelaw regulations, Sustainable built environment, NBC standards, Regulations,

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Optimizing Energy optimization, GHG, CFC.

1. Introduction

India's urban population has surged post-independence due to economic policies, growing from 11.4% in 1901 to over 30% by 2011 and projected to reach 40% by 2031 (McKinsey Global Institute, 2013). Currently, about 30% of India's 221.1 million households are urban, expected to more than double by 2050 (TERI, 2010).

To cope with the pressures of urbanization in India, large-scale development is rapidly expanding across various sectors, especially real estate. This transformation demands increased energy and resources, resulting in a rising per capita consumption of natural resources. Consequently, it accelerates ecosystem exploitation, ultimately threatening global biodiversity.

Study reports from the Ministry of New and Renewable Energy, Government of India, Buildings continuously consume massive amount of energy in their construction, operation and its maintenance.

As per the Statistics by U.S. Bureau of Labor Statistics and the EPA, buildings are always the major consumers of the total energy (40%), water, electricity (72%), greenhouse gas emissions (38%), raw materials usage (40%), waste output (40%), and consumers of portable water (14%). As per UN Environment and International Energy Agency 2017 report, in India electricity use in buildings has increased more than 500% since 2010, contributing to 49% of the greenhouse gas emissions (GRIHA Council and The Energy and Resources Institute, 2021)

2. Need for the mandatory sustainable building byelaw regulations to promote carbon neutrality in India.

Ancient Indian architecture effectively utilized passive design strategies such as optimal orientation, strategic openings, shading devices, and surrounding vegetation to enhance indoor thermal comfort naturally. However, modern buildings often neglect these principles, leading to increased energy consumption and issues like Sick Building Syndrome (Bansal Narendra, 1994).

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This has renewed interest in sustainable architecture, where architects and engineers are integrating passive cooling and heating techniques using vernacular, renewable materials to minimize environmental impact while improving indoor comfort.

In India, building byelaw regulations are created on the National building code (NBC) but can be modified by states to meet local needs, often neglecting sustainability. Rapid urbanization and changing lifestyles have increased resource consumption, placing strain on ecosystems. Unlike countries like Singapore, India lacks mandatory sustainable byelaw regulations, with limited attention to setbacks and building spacing needed for daylight and ventilation in dense urban areas. While some green certifications exist, they are voluntary in nature and often overlook traditional practices that could enhance sustainability. Sustainable byelaw regulations should address daylighting, energy efficiency, ventilation, water management, and waste disposal, integrating buildings more harmoniously with natural cycles and microclimates.

In several countries such as Singapore and in large parts of Europe, the important environmental and sustainable features of buildings and their integration into building byelaw regulations are equally well implemented. In our country, environmental building guidelines do exist, but relevant building byelaw regulations for encouraging a sustainable built environment are not in place.

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3.Importance of building byelaw regulations encouraging sustainable built forms in urbanizing India.

As per the Brundtland report, also known as ‘Our Common Future’ published in 1987 by the World Commission on Environment and Development (WCED), “sustainable development is the development that meets the demands of the present without compromising the abilities of the future generations to meet their own needs”.

Furthermore, sustainable development enforced through building regulations should guide the practice of creating structures, systems, and processes that have low environmental impact and safeguards resource efficiency throughout the life cycle to minimize the briefly enlisted effects in Table 1

Aspects of Built Environment	Consumption	Environmental Effects	Ultimate Effects
Siting	Natural resources	Waste	Harm to humans
Design	Energy	Air pollution	Environment degradation
Construction	Water	Water pollution	Loss of resources
Operation	Materials	Indoor pollution	
Maintenance		Heat islands	
Renovation		Storm-water runoff	
Deconstruction		Noise pollution	

Source: Environmental Protection Agency (2016)

Table 1 - Effects on the environment

Building byelaw regulations have been framed by municipal legislations, local government acts, or development authorities within their jurisdiction under the municipal acts of the respective state governments.

The Central Government plays a regulatory role by establishing model municipal acts,

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building codes, and periodic amendments to address the evolving urban needs with a futuristic approach.

City Master Plans provide a framework for spatial planning, zoning, development, and control regulations, aligning with the Urban Development Plans Formulation & Implementation (URDPFI) guidelines (2015) issued by the Ministry of Urban Development, government of India. The Model Building Byelaw regulations (2004), prepared by the Town and Country Planning Organization (TCPO), serve as a reference for revising state and local building regulations. Many provisions are derived from the National building code (NBC), particularly concerning development control regulations that shape urban forms.

Building very significantly influences a city's character and is regulated through land use, Floor Area Ratio (FAR), setbacks, and ground coverage. These regulations contribute to public health, quality of life, urban aesthetics, and the liveability of streets and open spaces. Beyond structural aspects, buildings primarily serve to protect human health and well-being by ensuring thermal comfort, hygiene, and adequate lighting. According to Bansal J.C. (2001), these comfort factors—thermal, light, and hygiene should be achieved through renewable energy sources to promote sustainable built environments.

4.Current Initiatives and Gaps

While voluntary frameworks like the Indian Green Building Council (IGBC), LEED, Green Rating of Integrated Habitat Assessment (GRIHA), encourages sustainable practices yielding to net zero carbon-built environments. However, their on-mandatory nature limits widespread adoption. The Eco-Niwas Samhita (ENS) 2024, developed by the Bureau of Energy Efficiency, provides guidelines for energy conservation in residential buildings, addressing aspects like building envelope design and renewable energy integration. Despite these initiatives, the absence of compulsory sustainable building byelaw regulations means that many developments do not prioritize carbon neutrality

A well-structured, climate-responsive, and sustainable architectural approach, supported by effective building regulations, plays a crucial role in preserving natural resources like ground cover, forests and water. It decreases greenhouse gas emissions while optimizing energy consumption with renewable materials and energy sources. Additionally, such an approach fosters a sustainable built environment, ensuring thermal and visual comfort by leveraging nature's energy sources with minimal environmental impact.

Sustainable practices should also focus on water conservation, recycling, reuse, solid waste segregation, efficient waste management, and resource recovery from waste. However, urban expansion in many developing countries remains mainly unplanned and uncontrolled, except in a few newly developed cities. Challenges such as unregulated organic growth, chaotic traffic congestion at nodal junctions, illegal settlements on public land, narrow and congested roads, unplanned fringe development, and scattered solid waste dumps are prevalent. Furthermore, when governments attempt to enforce regulations—such as land use conversions, additional FAR through TDR/TOD developments, and incentive zoning—

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without considering the unpredictable urban growth patterns and public awareness, it often leads to urban degeneration. This not only affects place identity and quality of life but also increases concerns about public health and safety. This situation prompts a critical evaluation on the feasibility of the existing building byelaw regulations responsible for these challenges and questions the lack of proper implementation that contributes to this urban crisis. As a summary, there is a severe need for the exclusive, compliant and comprehensive sustainable guidelines for built environment for most of the Indian cities

5. Review of NBC 2016, BIS standards, ECBC to explore sustainability guidelines

The National building code (NBC) 2016, Part-8, Volume-2 (Bureau of Indian Standards, 2016) on Building Services emphasizes energy-efficient design and processes, particularly through improved daylight factors for four-story building blocks. This approach significantly reduces artificial lighting requirements, leading to lower energy consumption and encouraging health benefits such as reduced eyestrain caused by prolonged exposure to artificial lighting.

Given that India experiences clear skies over 95% of the time, every architectural design and built form has the opportunity to fully utilise the natural daylight, maximizing both energy efficiency and occupant well-being.

Table-2 – Showing the Review of NBC, BIS standards and ECBC, highlighting the provisions to achieve built form with energy efficient designs.

6. Existing policies, regulations and incentives encouraging sustainable built environment: case example of Indian cities.

Several Indian states and cities have incorporated incentives within their building byelaw regulations to promote the implementation of GRIHA (Green Rating for Integrated Habitat Assessment) certified buildings. These incentives aim to encourage sustainable construction practices and enhance environmental performance. Below is an overview of existing policies, regulations, and incentives supporting GRIHA-rated buildings across various regions:

Ministry of Urban Development, Government of India: Issued a notification for local authorities to provide 1% to 5% extra ground coverage and Floor Area Ratio (FAR) for projects on plots larger than 3,000 square meters based on GRIHA evaluation.

Punjab: Offers an additional 5% free FAR for GRIHA-certified projects.

Rajasthan: The Jaipur Development Authority provides an additional 5% free FAR for GRIHA-rated buildings.

Haryana: The Haryana Building Code 2017 awards additional FAR of up to 9% for GRIHA-rated projects.

Uttar Pradesh: The Housing and Urban Planning Department offers a free 5% additional FAR for projects achieving a 4 or 5-star GRIHA rating.

Pimpri Chinchwad Municipal Corporation (PCMC), Maharashtra: Provides dis-counts in premiums for developers based on the level of GRIHA or SVA GRIHA star rating achieved.

Pune Municipal Corporation (PMC), Maharashtra: Offers discounts in premium charges for developers undertaking new construction projects that accomplish GRIHA or SVA GRIHA certification.

NOIDA and Greater NOIDA, Uttar Pradesh: Incentivize GRIHA projects on plots larger than 5,000 square meters by offering benefits such as additional FAR.

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<table>
<tr>
<td>NBC-2016. Table—7, clause-4.2.9 Volume-II Part-8, section-1, Natural lighting and ventilation.

(Bureau of Indian Standards, 2016) shows the relative availability of the daylight on the window planes at the ground floor level in a four-storied building blocks.</td>
<td>
<table>
<tr><th>SI No.</th><th>Distance of Separation Between Blocks</th><th>Infinitely Long Parallel Blocks</th><th>Parallel Blocks Facing Each Other(Length - 2 x Height)</th><th>Parallel Blocks facing Gaps Between Opposite Blocks(Length = 2 x Height)</th></tr>
<tr><td>i)</td><td>0.5 Ht</td><td>0.15</td><td>0.15</td><td>0.25</td></tr>
<tr><td>ii)</td><td>1.0 Ht</td><td>0.30</td><td>0.32</td><td>0.38</td></tr>
<tr><td>iii</td><td>1.5 Ht</td><td>0.40</td><td>0.50</td><td>0.55</td></tr>
<tr><td>iv)</td><td>2.0 Ht</td><td>0.50</td><td>0.60</td><td>0.68</td></tr>
</table>
NOTE - Ht - Height of building.

Relative availability of the daylight on the surface of window planes at the ground floor level in four-storied building blocks (clear design-sky as basis for the daylight availability on façade & values are for the center of the blocks).</td>
</tr>
<tr>
<td>1S: 7662 (Part I) Indian Standard recommendations for orientation of buildings.</td>
<td>Recommendations for the orientation of buildings- Gives the clarity for manual calculation for the orientation of the building to receive minimum solar radiation according to the location of the place, calculated from the total radiations from direct plus diffused) incident on the numerous surfaces of buildings, shown in W/m^2/ day, for summer and winter seasons· ((Clause B-1.3 and B-1.4)</td>
</tr>
<tr>
<td>NBC-2016 volume I, Part 3, 8.2.6.1

(Bureau of Indian Standards, 2016)</td>
<td>Recommends abutting setbacks in the air for the building of 24M Height, 37.5M height and tall buildings.

For the building of heights having 24M and 37.5M with one setback, open spaces at the ground level shall not be less than 9M -proposes the diminishing floors to maintain maximum penetration of natural daylighting</td>
</tr>
<tr>
<td>As per Part-8 NBC 2016, Volume-1I Building services. Section-1, Lighting and Natural Ventilation. (Clauses 4.1.3.1,4.1.4,4.1.4.2,4.3.2 and 4.3.2.1).

(National Building Code 2016, vol-2, 2016).</td>
<td>Recommended values of illuminance for internal activities to preserve human visual comforts.</td>
</tr>
</table>

Table-2 – Showing the Review of NBC, BIS standards and ECBC,

Source: National building code -2016-Volume2, ECBC, 1S: 7662 (Part I)

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Table-3 Showing existing policies and building byelaw regulations in Indian cities, supporting sustainable built environment.

SI No	Development Authority	Existing regulatory framework for encouraging sustainable buildings.
1	Chandigarh Master Plan 2031.	Commercial buildings, institutional buildings and hotel buildings shall provide a solar water heating system within one year after the law came into effect. Residential buildings will have two years of time for fixing a solar water heater. Water Conservation: All buildings with toilets/washrooms must mandatorily install a dual-flush system with a maximum capacity of 7 liters per W.C. to ensure water conservation.
2	Municipal administration and urban development department – Andhra Pradesh Building Rules, 2012	All buildings exceeding 300 Sq. m shall be required to comply with Green Building norms. APECBC norms shall be applicable to plots exceeding 100 Sq. m or buildings with a built-up area of more than 2,000 Sq. m City level infrastructure impact fees.
3	Bangalore Development Authority. RMP 2015.	While granting license, the Authority imposes a condition on planting trees for 2400sqft. and above sites. Additionally, few more conditions like, open spaces, setbacks, F.A.R, ground coverage, building height, distance between two multi storied buildings, solar water heating and lighting, rainwater harvesting, planting trees.
4	Proceedings of Govt of Karnataka, Publication of Model Building Byelaw regulations for Urban areas.	Environmental compliance throughout Building approvals. The ministry of environment, forest and climate change (MOEFCC) has tried to integrate the environmental concern into building plan sanction process and empowering the concerned local body to approve and certify compliance of stipulated requirements. Building categories are specified as below, starting Built up Area from 5000 Sq, m and above. (1) Building category- 1 built-up area of 5,000 Sq. m to < 20,000 Sq. m. (2) Building category - 2, built-up area of ≥ 20,000 Sq. m to 50,000 Sq. m. (3) Building category - 3 built-up area of ≥ 50,000 Sq. m to 1,50,000 Sq. m.

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Table-3 Showing existing policies and building byelaw regulations in Indian cities, supporting sustainable built environment.

SI No	Development Authority	Existing regulatory framework for encouraging sustainable buildings.
5	Ghaziabad Development Authority (GDA)	Fast track environmental clearance by MOEF
6	The Pimpri Chinchwad Municipal Corporation (PCMC), Maharashtra	Financial Incentives for Developers: Up to 50% rebate on the premium paid to the municipal body for the projects achieving 5-Star GRIHA compliance. Property Tax Rebate: 10% reduction, valid for 5 years, for buildings complying with the 5-Star GRIHA standards
7	Ahmedabad Municipal Corporation Authority.	Reuse of Wastewater & Solar Energy Utilization: Mandatory for plots/buildings with an area exceeding 5,000 sq.m. Percolation Pits: Required for plots measuring 500 sq.m. Percolation Wells: Mandatory for plots larger than 1,500 sq.m and 4,000 sq.m. Rainwater Storage Tanks: Required for plots exceeding 1,500 sq.m to ensure efficient rainwater harvesting. Water Storage Ponds: Essential for large construction projects to enhance water conservation.
8	Unified building byelaw regulations-2013 and development control regulation of master plan of New Delhi- 2031.	The building plan sanctioning authority may grant an additional 1% of permissible FAR as an incentive for projects designed as energy-efficient buildings incorporating innovative systems and techniques. This incentive applies specifically to buildings that feature facade cladding up to 80mm thickness and cavity walls for insulation, enhancing thermal efficiency and reducing energy consumption.

Sources- Chandigarh master plan 2031, Municipal administration and urban development department – Andhra Pradesh building rules, 2012, RMP 2015, Bangalore development authority, Proceedings of Govt of Karnataka, Publication of Model Building Byelaw regulations for Urban areas, Ghaziabad Development Authority (GDA), The Pimpri Chinchwad Municipal Corporation (PCMC), Maharashtra, Ahmedabad Municipal Corporation Authority

Sikkim: The state government has adopted GRIHA as the green building rating system, encouraging sustainable building practices. **The Ministry of environment and forests (MoEF)**, environmental impact assessment (EIA) and Clearance. This is a compulsory requirement for all buildings with a built up area above 20,000 sq. m and such growths have to be imparted by the MoEF's EnvironmentalAppraisalCommittees(EACs) and by the State environmental appraisal committees (SEACs).

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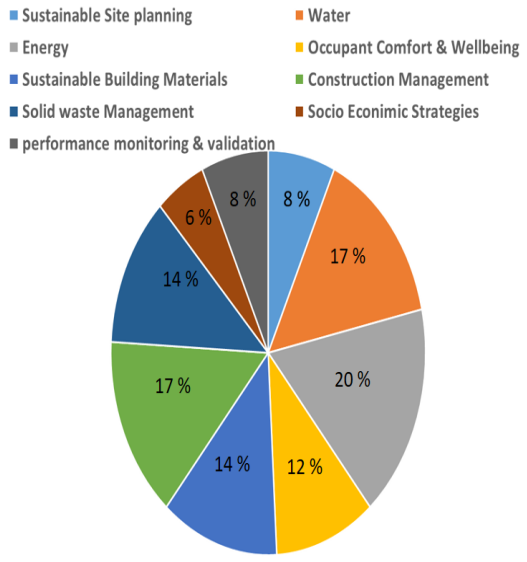
7. Inferences

Of the number of planning tools, from development plan to town planning scheme, to building byelaw regulations, the building byelaw regulations remain to be the most promising and effective tool in shaping the built environment. They not only define the physical urban character but also influence the environmental conditions and encourage or inhibit social interaction. Building Regulations can be integrated with similar sustainable indices as identified by GRIHA to minimize the environmental impact through built forms.

Fig- 1 Chart showing Sustainability Indices as defined by TERI, GRIHA rating systems.



Source- Sustainability Indices from "The energy resources institute (TERI)", GRIHA rating systems, (Minni Sastry, 2018)

Building byelaw regulations are the tools in the hands of policy makers to control the various parameters affecting the quality of life through buildings. It is also helpful in providing the policy for implementing the authorities to carry out a sustainable, systematic and futuristic development through the set of regulations implemented as policies to promote the sustainable and low carbon (less energy consuming) built environment.

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