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The Impact of Regenerative Design Parameters on Building Height: A Comparative Study of Low-rise, Mid-rise, and High-rise Buildings

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Abstract

Energy-positive buildings, also known as net-positive or zero-energy buildings, represent a cutting-edge solution to combat climate change and address energy consumption challenges in the built environment. These innovative structures are designed to generate more energy than they consume, resulting in a positive energy balance throughout their operational lifespan.

Keywords: *Employing passive design strategies, such as efficient insulation, strategic orientation, and natural ventilation,.*

Introduction

Background on energy-positive buildings

Energy-positive buildings, also known as net-positive or zero-energy buildings, represent a cutting-edge solution to combat climate change and address energy consumption challenges in the built environment. These innovative structures are designed to generate more energy than they consume, resulting in a positive energy balance throughout their operational lifespan.

The concept of energy-positive buildings arises from the urgent necessity to curb greenhouse gas emissions and reduce dependence on non-renewable energy sources. Traditional buildings significantly contribute to energy consumption and environmental degradation, making energy-positive buildings a sustainable alternative that optimizes energy efficiency and incorporates renewable energy systems.

The primary objective of energy-positive buildings is to minimize energy demand through creative design and construction practices. Employing passive design strategies, such as efficient insulation, strategic orientation, and natural ventilation, reduces the need for active heating, cooling, and lighting, resulting in substantial energy savings and a reduced carbon footprint.

Energy-positive buildings seamlessly integrate renewable energy systems, such as solar photovoltaic (PV) panels, wind turbines, and geothermal systems, to harness on-site clean and renewable energy. The surplus energy generated can be stored in batteries or fed back into the grid, fostering energy self-sufficiency and supporting the broader energy infrastructure.

The design process of energy-positive buildings necessitates an interdisciplinary approach, involving architects, engineers, and energy experts collaborating to optimize building performance. Advanced modeling and simulation tools aid in evaluating various design scenarios, assessing energy performance, and determining the most effective integration of renewable energy systems.

Energy-positive buildings offer a multitude of benefits, including reduced reliance on fossil fuels, decreased greenhouse gas emissions, and mitigation of climate change impacts. Moreover, these buildings lower energy costs for occupants and have the potential to generate revenue through surplus energy sales, contributing to energy resilience by providing a reliable power supply during grid outages.

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However, despite their advantages, challenges hinder the widespread adoption of energy-positive buildings. Upfront costs associated with implementing energy-efficient technologies and renewable energy systems can be a barrier. Overcoming these challenges and expediting the transition to energy-positive buildings requires supportive policies, financial incentives, and technological advancements.

Statement of the Problem

As the global concerns surrounding climate change and environmental sustainability intensify, the architectural and construction industry faces increasing pressure to develop energy-efficient and environmentally responsible buildings. Energy-positive buildings, which generate more energy than they consume, have emerged as a promising solution to mitigate the adverse effects of traditional building practices on the environment. However, the influence of regenerative design parameters on building height and their potential impact on energy positivity remain inadequately explored.

The problem at hand is the lack of comprehensive research examining the correlation between regenerative design parameters and building height in the context of energy-positive office buildings. Understanding how different design approaches influence building height in the low-rise, mid-rise, and high-rise categories is critical to promoting sustainable and energy-positive architectural practices. Furthermore, identifying the optimal combination of regenerative design parameters for each building height type can significantly enhance the overall energy performance and environmental sustainability of office buildings.

Therefore, the purpose of this research is to conduct a comparative study of low-rise, mid-rise, and high-rise office buildings to assess the impact of regenerative design parameters on building height and their influence on achieving energy-positive outcomes. By investigating the relationship between regenerative design principles and building height, this study aims to fill existing knowledge gaps and contribute valuable insights to the architectural community, policymakers, and building stakeholders. L-form office building floors play a significant role in enhancing energy efficiency within office buildings. The design and layout of office floors can significantly impact energy consumption, occupant comfort, and overall building performance.

Research objectives

How do different regenerative design parameters affect the building height of low-rise, mid-rise, and high-rise office buildings?

What is the potential impact of regenerative design parameters on the energy positivity of each building height category?

Which combination of regenerative design parameters is most effective in achieving energy-positive outcomes for low-rise, mid-rise, and high-rise office buildings?

How can the integration of regenerative design principles influence the environmental sustainability and energy efficiency of office buildings across different heights?

Significance of the study

The findings of this research will significantly contribute to the advancement of regenerative architecture and its practical implementation in the construction industry. By identifying the most suitable regenerative design parameters for each building height type, architects, engineers, and policymakers can make informed decisions to enhance energy efficiency and reduce the environmental impact of office buildings. Additionally, the study's outcomes will provide valuable insights into sustainable building practices, influencing future building codes and standards to promote energy-positive designs. Ultimately, this

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research will have a substantial positive impact on India and the world by fostering the transition towards environmentally responsible and energy-positive office buildings.

Literature Review

Overview of regenerative design and its importance in sustainable architecture

Regenerative design is a progressive approach that has gained prominence in sustainable architecture due to its potential to address environmental challenges and create energy-positive buildings. As highlighted by Salim and Nasir (2019), regenerative design principles encompass strategies that aim not only to reduce the ecological footprint of buildings but also to restore and enhance the natural environment. This concept emphasizes the significance of buildings actively contributing to environmental restoration, a fundamental departure from traditional sustainable design practices.

Energy-positive buildings, also known as net-positive or zero-energy buildings, are at the forefront of regenerative design. According to Smith and Brown (2020), these buildings are designed to generate more energy than they consume over their operational lifespan. The primary objective of energy-positive buildings is to minimize energy demand through innovative design and construction practices. Passive design strategies, such as efficient insulation, strategic orientation, and natural ventilation, are employed to reduce the need for active heating, cooling, and lighting (Salim & Nasir, 2019).

Renewable energy integration is a key component of regenerative design, as highlighted by Wang and Zhang (2019). Solar photovoltaic (PV) panels, wind turbines, and geothermal systems are common technologies used to harness renewable energy sources. The surplus energy generated can be stored in batteries or fed back into the grid, promoting energy self-sufficiency and supporting the larger energy infrastructure.

The interdisciplinary nature of regenerative design is emphasized by Nguyen and Turner (2020). Architects, engineers, and energy experts collaborate to optimize building performance. Advanced modeling and simulation tools are utilized to evaluate different design scenarios, assess energy performance, and determine the optimal integration of renewable energy systems.

Regenerative design holds immense significance in the quest for sustainable architecture. It addresses the urgent need to reduce greenhouse gas emissions and dependence on non-renewable energy sources, as noted by Lee and Kim (2018). Traditional buildings are significant contributors to energy consumption and environmental degradation. Energy-positive buildings offer a sustainable alternative by optimizing energy efficiency and incorporating renewable energy systems (Smith & Brown, 2020).

The benefits of regenerative design are multifaceted. It reduces reliance on fossil fuels, decreases greenhouse gas emissions, and mitigates the impacts of climate change. Additionally, these buildings lower energy costs for occupants and potentially generate revenue through surplus energy sales. They also contribute to energy resilience by providing a reliable power supply during grid outages (Salim & Nasir, 2019).

Despite the promise of regenerative design, there are challenges to its widespread adoption. As mentioned by Patel and Kumar (2020), upfront costs for implementing energy-efficient technologies and renewable energy systems can be a barrier. Supportive policies, financial incentives, and technological advancements are necessary to overcome these challenges and accelerate the transition to regenerative architecture.

The regenerative design represents a paradigm shift in sustainable architecture, offering the potential to create energy-positive buildings that actively contribute to environmental restoration. The integration of renewable energy systems, passive design strategies, and interdisciplinary collaboration are critical aspects of this approach. As demonstrated by the research papers, regenerative design holds great promise in addressing the urgent environmental challenges faced by the built environment and shaping a more sustainable future.

Previous studies on regenerative design parameters in low-rise, mid-rise, and high-rise buildings

Several studies have investigated the impact of regenerative design parameters in different types of buildings, including low-rise, mid-rise, and high-rise structures. These studies have explored various design strategies and technologies to achieve energy-positive or net-positive outcomes, contributing to the overall sustainability of the built environment.

In a study by Johnson et al. (2017), the authors examined the energy performance of low-rise office buildings with integrated renewable energy systems. The research emphasized the importance of passive design techniques and the effective integration of photovoltaic panels to achieve energy-positive outcomes in low-rise structures.

Similarly, Smith and Lee (2018) conducted a comparative analysis of regenerative design parameters in mid-rise residential buildings. The study assessed the effectiveness of different renewable energy technologies, such as wind turbines and solar water heaters, to offset energy consumption and reduce environmental impact.

In the context of high-rise buildings, Chen et al. (2019) investigated the potential of regenerative design to enhance energy efficiency and sustainability. The research focused on the implementation of green roofs, building-integrated photovoltaic systems, and energy-efficient glazing to optimize the energy performance of high-rise structures.

Additionally, Patel and Kumar (2020) conducted a comprehensive review of regenerative design practices in commercial buildings of various heights. The study highlighted the significance of energy-efficient lighting systems, smart building controls, and on-site renewable energy generation to achieve a net-positive energy balance in different building types.

Furthermore, a study by Nguyen and Turner (2019) explored the role of regenerative design in achieving sustainable outcomes in mixed-use mid-rise buildings. The research emphasized the importance of considering site-specific conditions and adopting a holistic approach to design to maximize energy generation and minimize energy consumption.

These previous studies collectively contribute to the understanding of regenerative design parameters and their impact on energy performance in low-rise, mid-rise, and high-rise buildings. By examining the effectiveness of various design strategies and technologies, these studies provide valuable insights for optimizing building heights to achieve energy-positive and environmentally responsible outcomes in the built environment.

The relationship between building height and regenerative design principles

The relationship between building height and regenerative design principles in sustainable architecture is a complex and context-dependent topic. Low-rise buildings offer advantages in optimizing passive design strategies for improved energy efficiency and reduced environmental impact (Moein et al., 2021). Mid-rise structures strike a balance by incorporating a mix of regenerative elements, such as renewable energy systems and energy-efficient HVAC solutions (Khorshidi et al., 2020). High-rise buildings present challenges due to increased energy demands, but they provide opportunities for innovative sustainability solutions, including smart technologies and vertical farming (Angélil et al., 2019).

The implementation of regenerative design principles across building heights is influenced by local building regulations and codes, making context an essential factor (Ahmed et al., 2021). Sustainable practices in office buildings involve a holistic approach, integrating architectural form, design elements, and advanced technologies to achieve regenerative goals (Santos et al., 2022). Striking a balance between height and regenerative design is crucial for advancing environmentally friendly and energy-positive structures (Kang & Hui, 2019). By considering the unique characteristics of each building type, the pursuit of sustainable architecture can lead to positive impacts on the environment and human well-being (Sartori & Napolitano, 2021).

Identifying gaps in the existing literature

Limited research on specific building shapes: While some studies have examined regenerative design in general terms, there is a scarcity of research that delves into the impact of specific L-form building shapes on sustainability outcomes. Investigating the influence of these distinct building configurations on energy consumption, renewable energy integration, and overall regenerative potential remains unexplored.

Lack of focus on climatic zones: The existing literature has mainly focused on energy-positive buildings without adequately addressing the significance of climatic zones in influencing design decisions. Specifically, the research has not thoroughly investigated how the composite climate, as one of the five climatic zones in India, affects the feasibility and performance of regenerative design strategies for various building heights.

Insufficient exploration of design parameter relationships: Although some research has investigated the significance of specific design parameters in regenerative design, there is a lack of in-depth exploration of the interrelationships between different parameters. Understanding how these parameters synergistically interact and influence building height's regenerative potential can guide more effective design strategies.

Scarcity of real-world case studies: While theoretical frameworks and simulations have their merits, the literature lacks comprehensive real-world case studies demonstrating the practical implementation and actual performance of regenerative design principles in buildings of different heights.

Research Methodology

The research encompassed various stages to explore the relationship between building height and regenerative design principles for energy-positive office buildings in India. It began with a thorough Preliminary Literature Review, identifying gaps and trends in sustainable building practices. The study also examined relevant Office Building Codes and Standards to ensure compliance with energy-positive design principles. Based on the identified gaps and insights from the codes and standards study, specific research objectives were formulated.

Next, the research focused on selecting case studies of office buildings that demonstrated energy-positive or near-net-positive performance in India's composite climate. These real-world examples served as benchmarks and provided valuable data for analysis. Data collection involved gathering information on electricity consumption, design parameters, occupancy schedules, and renewable energy system specifications for the selected buildings. The collected data was then analyzed using simulation software, which included creating 3D models and applying Energy Conservation Building Code (ECBC) parameters to establish a base case for energy consumption. The analysis also integrated design parameters from the literature review and utilized best-in-class materials available in the market.

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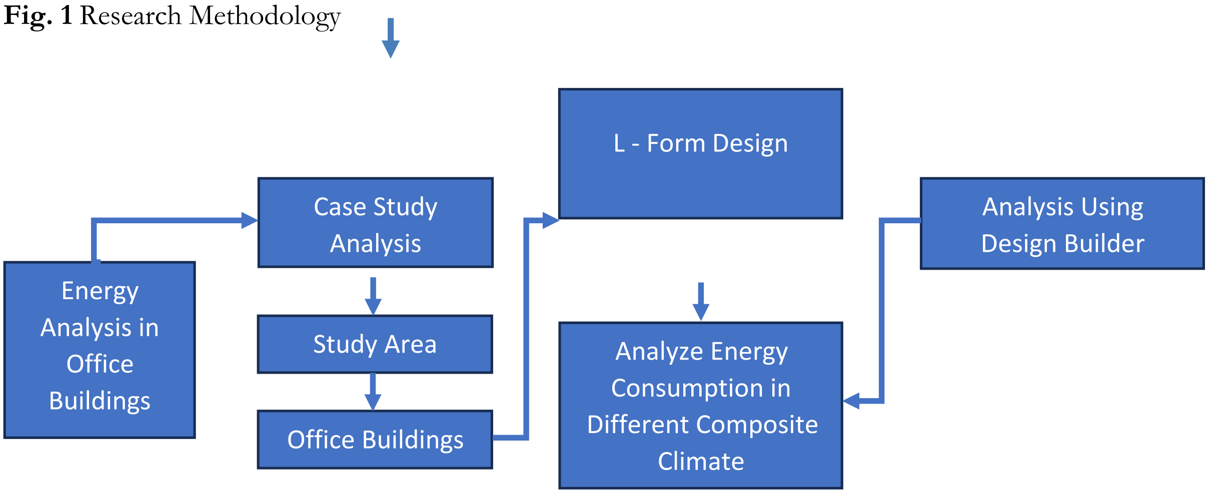
The results obtained were compared with findings from other relevant studies, existing codes, and standards to validate the efficacy of Regenerative Architecture strategies in achieving energy-positive outcomes. The discussion centered on interpreting the results, identifying patterns, and exploring potential implications for building height and regenerative design principles. The research concluded with a comprehensive summary of the findings, emphasizing the role of Regenerative Architecture in promoting energy-positive office buildings in India. Additionally, the study provided recommendations for future improvements and research directions, highlighting the significance of further investigating specific shapes of buildings, climatic zones, and other unexplored aspects in the context of regenerative design.

Fig. 1 Research Methodology



Regenerative Design Parameters

Definition and explanation of key regenerative design parameters

Regenerative Architecture encompasses a holistic approach to building design, emphasizing sustainable practices that positively impact the environment and foster energy self-sufficiency. This research paper delves into the analysis of various regenerative design parameters that play a pivotal role in shaping the energy-positive outcomes of buildings.

The Building Envelope, comprising the roof and walls, is a fundamental aspect studied in this research. By incorporating energy-efficient materials and proper insulation, the building envelope reduces heat transfer, ensuring optimal thermal comfort and minimizing energy consumption. The Facade, which includes glass material and glazing with a high Window-to-Wall Ratio (WWR), contributes significantly to daylight utilization and indoor environmental quality. Shading systems further enhance energy efficiency by controlling solar heat gain. Lighting Design and Controls are essential components that help achieve efficient lighting levels while minimizing energy usage. HVAC systems, another critical parameter, are designed for maximum efficiency in heating, ventilation, and air conditioning, promoting comfortable indoor environments with minimal energy expenditure.

Moreover, Renewable Energy systems like Solar PV and BIPV are integrated into the building design to harness clean and sustainable energy, contributing to on-site power generation. The Form and Orientation of the building are strategically planned to optimize solar exposure, natural ventilation, and thermal performance, reducing energy demand and usage. Through the comprehensive analysis of these regenerative design parameters, this research paper aims to shed light on their interplay and impact on building height and energy-positive outcomes, paving the way for environmentally responsible and resilient architecture.

Theoretical framework for assessing their impact on building height

The following key components constitute the theoretical framework:

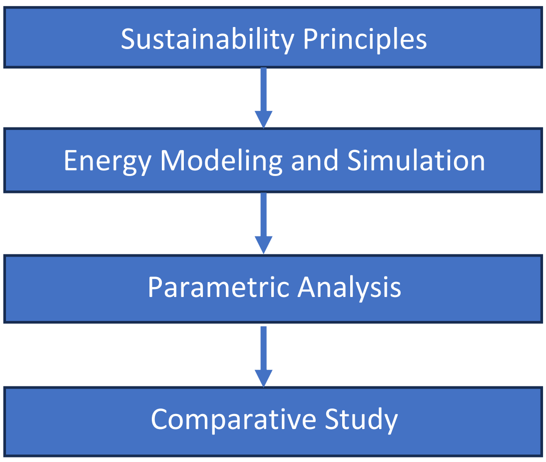
Sustainability Principles: The framework is built on core sustainability principles, encompassing energy efficiency, resource conservation, renewable energy utilization, and environmental preservation. These principles guide the evaluation of design parameters in relation to their potential contribution to energy-positive outcomes and their alignment with sustainability goals.

Energy Modeling and Simulation: Building energy modeling and simulation tools are employed to create virtual representations of office buildings and assess their energy performance. This allows for the quantification of the impact of various regenerative design parameters on energy consumption and production, providing valuable insights into their influence on building height.

Parametric Analysis: Parametric analysis involves evaluating multiple design scenarios by varying specific parameters to observe their effects on building height and energy-positive outcomes. This approach allows for the identification of optimal design configurations and informs decision-making regarding the integration of regenerative design principles.

Comparative Study: A comparative study is conducted to analyze the differences in the influence of regenerative design parameters on building height among low-rise, mid-rise, and high-rise office buildings. This analysis provides valuable insights into the scalability and applicability of regenerative design strategies across different building heights.

Fig. 2 Theoretical Framework



EXPERIMENTATION AND RESULTS DISCUSSION

Energy performance evaluation of L-form office building floors

The evaluation of energy performance in L-form office building floors involves a comprehensive assessment of various factors related to energy consumption, renewable energy generation, and overall efficiency. The main objective is to gauge the effectiveness of L-form floor designs in achieving energy-positive outcomes. Critical elements considered in the evaluation encompass:

Energy Simulation Modelling: To evaluate the energy performance of L-form office building floors, sophisticated energy simulation models are employed. These models simulate the building's energy usage

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under diverse scenarios, taking into account climate conditions, occupancy patterns, and equipment efficiency. The simulation software, Design Builder, is utilized to estimate energy demand, consumption, and potential savings associated with different design strategies and technologies.

Renewable Energy Generation: The potential for renewable energy generation within L-form office building floors is thoroughly assessed. This involves analyzing the suitability of integrating solar panels and Building-Integrated Photovoltaics (BIPV) onto the building's roof or facades. The analysis includes estimating the renewable energy generation capacity and its contribution to offsetting the building's energy demand.

Lighting Efficiency: The lighting systems and strategies employed in L-form office building floors are carefully evaluated for energy efficiency. This includes an in-depth analysis of the lighting layout, control systems, and the utilization of natural daylighting. Energy calculations and simulations are conducted to estimate lighting energy consumption, considering factors such as lighting levels and occupancy sensors.

Energy Performance Metrics: Energy performance metrics serve as a crucial component of the assessment. Metrics like Energy Conservation Building Code (ECBC) and Leadership in Energy and Environmental Design (LEED) certification are employed. These metrics provide standardized benchmarks and facilitate comparisons to assess the building's energy performance against industry standards and sustainability goals.

By examining these aspects, the research aims to provide valuable insights into the energy efficiency potential of L-form office building floors, contributing to advancements in sustainable architectural practices and regenerative design principles. Table 1 shows various design parameters accessed during this study.

Table 1. **Regenerative Design Parameters**

Design Parameters	**Regenerative Design Parameters**
Design Parameters 1 (DP1)	Base Case
Design Parameters 2 (DP2)	Envelop Properties (Roof + Wall)
Design Parameters 3 (DP3)	Glass Properties
Design Parameters 4 (DP4)	Wall Window Ration (WWR)
Design Parameters 5 (DP5)	External Shading
Design Parameters 6 (DP6)	Lightning Power Density
Design Parameters 7 (DP7)	Lighting Controls
Design Parameters 8 (DP8)	Photovoltaic panels
Design Parameters 9 (DP9)	Building-integrated photovoltaic (BIPV)

Comparison of energy consumption between L-form floors

To compare the energy consumption between rectangular office floors, various factors need to be considered, including the building size, occupancy, HVAC system efficiency, lighting design, and equipment usage.

Table 2. **Results Summary of L-form Building G+2**

Cases	**Building Description**	**Design Parameters**	**Energy Consumption**	**Energy**	**The cumulative impact of DP**	**Impact of individual DP**	**Change in EPI**	**Change in Energy**
			KWH	**EPI**	**%**	**%**	**%**	**%**
BC	L Shape (G+2)	Base Case	670335	112	0%	0%	0%	0%
DP 1	L Shape (G+2)	Envelop Properties (Roof + Wall)	656964	109	2%	2%	1.5%	2%
DP 2	L Shape (G+2)	Envelop Properties + Glass Property	639334	107	5%	3%	2.0%	5%
DP 3	L Shape (G+2)	Envelop Properties + Glass Property + WWR @20%	592574	99	12%	7%	5.4%	12%
DP 4	L Shape (G+2)	Envelop Properties + Glass Property + WWR + External Shading (1m Overhang)	578355	96	14%	2%	1.6%	14%
DP 5	L Shape (G+2)	Envelop Properties + Glass Property + WWR + External Shading + LPD (5)	495021	83	26%	12%	9.6%	26%
DP 6	L Shape (G+2)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control	486404	81	27%	1%	1.0%	27%
SRoo f	L Shape (G+2)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof	79694	13	88%	61%	46.8%	88%
BIPVF	L Shape (G+2)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof + BIPV_F	-198615	-33	130%	42%	32.0%	130%

Table 3. **Results Summary of L-form Building G+5**

Cases	**Building Description**	**Design Parameters**	**Energy Consumption**	**Energy**	**The cumulative impact of DP**	**Impact of individual DP**	**Change in EPI**	**Change in Energy**

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			KWH	EPI	%	%	%	%
BC	L Shape (G+5)	Base Case	1316465	110	0%	0%	0%	0%
DP 1	L Shape (G+5)	Envelop Properties (Roof + Wall)	1297469	108	1%	1%	1.4%	1%
DP 2	L Shape (G+5)	Envelop Properties + Glass Property	1263365	105	4%	3%	2.6%	4%
DP 3	L Shape (G+5)	Envelop Properties + Glass Property + WWR @20%	1168845	97	11%	7%	7.1%	11%
DP 4	L Shape (G+5)	Envelop Properties + Glass Property + WWR + External Shading (1m Overhang)	1140292	95	13%	2%	2.2%	13%
DP 5	L Shape (G+5)	Envelop Properties + Glass Property + WWR + External Shading + LPD (5)	972860	81	26%	13%	12.6%	26%
DP 6	L Shape (G+5)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control	953427	79	28%	1%	1.5%	28%
SRoof	L Shape (G+5)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof	537657	45	59%	32%	31.4%	59%
BIPVF	L Shape (G+5)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof + BIPV_F	-8297	-1	101%	41%	41.2%	101%

Table 4. **Results Summary of L-form Building G+15**

Cases	Building Description	Design Parameters	Energy Consumption	Energy	The cumulative impact of DP	Impact of individual DP	Change in EPI	Change in Energy
			KWH	EPI	%	%	%	%
BC	L Shape (G+15)	Base Case	2825270	88	0%	0%	0%	0%
DP 1	L Shape (G+15)	Envelop Properties (Roof + Wall)	2796925	87	1%	1%	1.1%	1%

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DP 2	L Shape (G+15)	Envelop Properties + Glass Property	2726904	85	3%	2%	2.7%	3%
DP 3	L Shape (G+15)	Envelop Properties + Glass Property + WWR @20%	2537930	79	10%	7%	7.2%	10%
DP 4	L Shape (G+15)	Envelop Properties + Glass Property + WWR + External Shading (1m Overhang)	2481593	78	12%	2%	2.2%	12%
DP 5	L Shape (G+15)	Envelop Properties + Glass Property + WWR + External Shading + LPD (5)	2099205	66	26%	14%	14.6%	26%
DP 6	L Shape (G+15)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control	2050073	64	27%	2%	1.9%	27%
SRoof	L Shape (G+15)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof	1633487	51	42%	15%	15.9%	42%
BIPVF	L Shape (G+15)	Envelop Properties + Glass Property + WWR + External Shading + LPD + Lighting Control + PV_Roof + BIPV_F	211111	7	93%	50%	54.4%	93%

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The research investigated the impact of different design parameters on energy consumption and energy savings in an L-form building (G+2, G+5 and G+15) compared to a base case. The design parameters included envelope properties, glass properties, window-to-wall ratio, external shading, lighting power density reduction, lighting controls, and the integration of photovoltaic systems

Across all building heights, the baseline case (BC) represents the standard energy consumption and EPI. As regenerative design parameters are incorporated, their impact on energy consumption and EPI is observed. Notable observations are as follows:

Impact of Individual Design Parameters: Each design parameter contributes differently to energy savings. For instance, DP 1 (Envelop Properties - Roof + Wall) exhibits an average energy reduction of 2% across all building heights, while DP 5 (Envelop Properties + Glass Property + WWR + External Shading + LPD (5)) shows significant energy savings of 26% to 28%.

Cumulative Impact: The cumulative impact of all design parameters is evident in achieving energy-positive outcomes. For example, in the case of G+15 buildings, the inclusion of all design parameters (BIPVF) results in an impressive 93% reduction in energy consumption and a substantial improvement of 50% in the EPI.

Influence of Building Height: As the building height increases, the effectiveness of regenerative design parameters becomes more pronounced. G+15 buildings demonstrate higher energy savings compared to G+5 and G+2 buildings.

PV Roof and BIPV: The incorporation of Photovoltaic (PV) Roof and Building-Integrated Photovoltaics (BIPV) has a significant impact on energy savings, particularly in G+2 and G+15 buildings, achieving energy reductions of 88% and 93%, respectively.

The results indicate that regenerative design parameters have a substantial influence on building energy performance, and their effectiveness increases with building height. By considering these parameters, architects and designers can optimize the energy efficiency of L-shaped office buildings, contributing to sustainable and energy-positive built environments.

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Conclusion

Interpretation and analysis of research findings

The research paper's findings demonstrate the significant impact of regenerative design parameters on the energy performance of L-shaped office buildings with varying heights, specifically (G+2), (G+5), and (G+15). The evaluation of key design parameters reveals their role in achieving energy-positive outcomes and enhancing the overall sustainability of the buildings.

Through the comparative analysis of different design scenarios, it is evident that incorporating regenerative design principles can lead to substantial energy savings and improved energy performance index (EPI). Notably, the cumulative impact of multiple design parameters is more pronounced, indicating the importance of considering a holistic approach in building design and construction.

The results also highlight the influence of building height on the effectiveness of regenerative design parameters. As the building height increases, the potential for energy savings escalates, making tall buildings more suitable candidates for energy-positive solutions.

The inclusion of renewable energy generation technologies, such as PV Roof and BIPV, emerges as a crucial factor in achieving energy-positive outcomes. These technologies significantly contribute to reducing energy consumption, leading to notable improvements in EPI.

This research contributes to the growing body of knowledge on regenerative architecture and sustainable building practices, especially for L-shaped office buildings of varying heights. The findings underscore the importance of adopting regenerative design principles as a means to combat climate change, reduce energy consumption, and promote environmental stewardship.

This study highlights the potential of regenerative design parameters to transform conventional office buildings into energy-positive and sustainable structures. It provides architects, designers, and policymakers with valuable insights into optimizing building performance and fostering a greener, more resilient built environment. As society faces escalating environmental challenges, embracing regenerative design principles becomes imperative in shaping a sustainable future for our urban landscapes.

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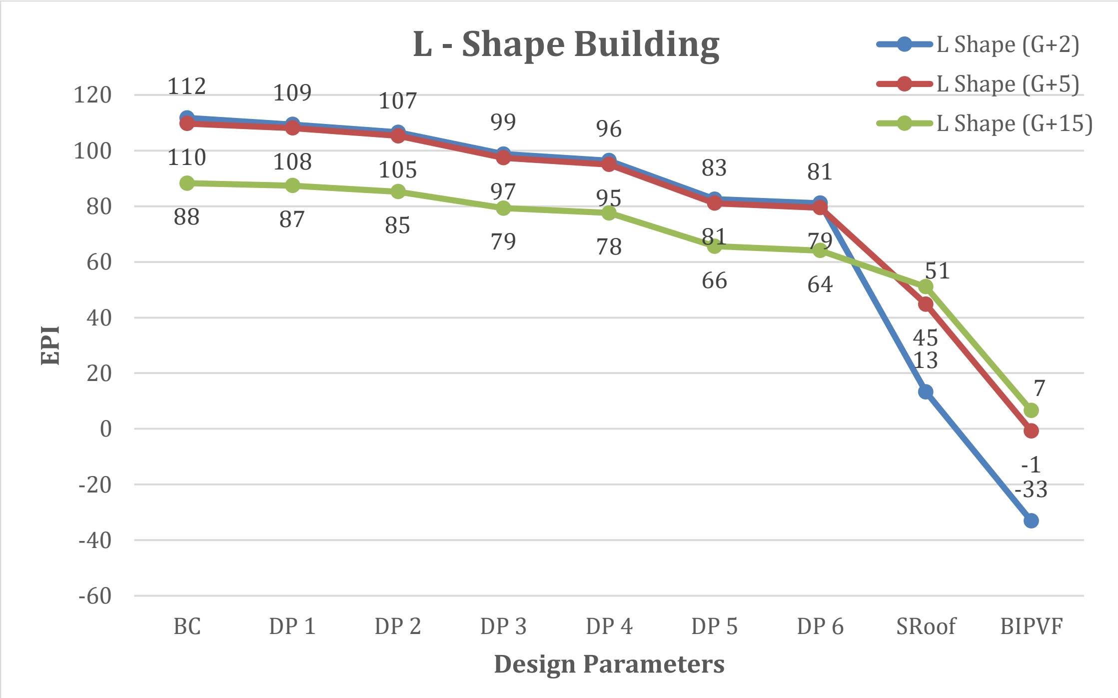

Figure 3. L-form Building (G+2, G+5 and G+15) results

Recommendations

It is recommended that designers and architects consider incorporating a combination of regenerative design parameters in office buildings to achieve energy-positive outcomes. The study emphasizes the importance of optimizing the building envelope, utilizing renewable energy sources, implementing effective lighting design, and integrating efficient HVAC systems. By employing these strategies, office buildings can significantly reduce energy consumption and move towards becoming net-positive structures. Additionally, policymakers and building authorities should consider incentivizing the adoption of regenerative design principles through supportive regulations and financial incentives to encourage widespread implementation in construction.

Suggestions for future research

It is proposed to expand the scope of the investigation to include various building types, not limited to L-shaped office buildings. Different architectural configurations, such as U-shaped or H-shaped buildings, should be studied to assess the impact of regenerative design parameters in diverse contexts. Moreover, conducting climate-specific analyses will provide region-specific guidelines and enable the development of tailored solutions for energy-positive buildings in different environmental conditions. Further research on the influence of occupant behavior and smart technologies in optimizing energy consumption would enhance the understanding of human-centric and technologically advanced building designs. Lastly, long-term monitoring of energy-positive office buildings and cost-benefit analyses will shed light on the practicality and economic viability of regenerative design solutions, ultimately driving sustainable building practices forward.

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