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REGENERATIVE ARCHITECTURE: INNOVATIONS, TECHNOLOGIES, AND ITS IMPACT

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Modern ecological challenges, such as climate change, degradation of natural resources and increased energy consumption, are driving the search for new approaches in construction and urban planning. Regenerative architecture is an innovative paradigm focused not only on reducing the negative impact of construction on the environment but also on its active restoration.

Digital modelling and 3D printing technology also play a role in implementing regenerative principles. The use of digital prototypes can optimise material consumption, reduce production waste and increase the energy efficiency of buildings, as evidenced by the research of Lucanto and co-authors. The use of 3D printing with eco-friendly materials, such as clay, biopolymers and recycled waste, makes it possible to create structures that harmoniously integrate into the natural environment and contribute to long-term sustainability.

The integration of natural elements into building systems is another important aspect of regenerative architecture. Marina One in Singapore is a landmark of sustainable and innovative architecture and urban design. Developed by Ingenhoven Architects, it seamlessly integrates architecture with nature, redefining how urban spaces function in tropical, high-density settings. The centerpiece of Marina One is the "Green Heart," a lush garden featuring over 350 species of plants. This design enhances biodiversity, reduces urban heat, and naturally improves the microclimate. It showcases how large-scale developments can coexist with nature..

Bird-friendly architecture is not only about conservation, but also about maintaining ecological balance. Birds play an important role in pollination, seed dispersal and pest control. Protecting birds contributes to the health of ecosystems and enhances the sustainability of the urban environment. One key feature of the

renovation was the use of fritted glass. This type of glass incorporates visible patterns, such as dots or stripes, making the panels highly visible to birds. Unlike regular clear or reflective glass, which often leads to birds mistaking it for open sky or vegetation, fritted glass provides visual cues to help birds avoid collisions.

The Jacob K. Javits Convention Center also used low-reflective surfaces to reduce misleading glare that often disorients birds. The project went beyond simply glass innovation. The centre of sustainability was an initiative that included a 6.75-acre rooftop green space that supports local biodiversity, providing habitat for more than 65 species of birds and other wildlife.

Scientific research proves that regenerative architecture has a multifaceted impact, covering environmental, economic and social aspects. Reducing greenhouse gas emissions, improving the quality of the environment and creating a comfortable living space contribute to both reducing operating costs and increasing the value of real estate. The further implementation of regenerative technologies — such as digital modelling, 3D printing, and the integration of natural elements into building systems — is essential for achieving a harmonious coexistence between cities and nature. These strategies also play a crucial role in ensuring environmental sustainability in the face of global challenges..

Thus, regenerative architecture represents a promising direction in contemporary construction, merging innovative technologies, optimal resource utilization, and active ecosystem restoration..

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