International Journal of
High-Rise Buildings
www.ctbuh-korea.org/ijhrb/index.php

International Journal of High-Rise Buildings
March 2022, Vol 11, No 1, 15-24
https://doi.org/10.21022/IJHRB.2022.11.1.15

Towards an Urban Troposphere

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Abstract Over the past 30 years, the tall building has seen unprecedented global support. With advanced innovation and many regions around the world discovering increasing growth rates, the tall, supertall, and megatall buildings continue to drastically alter the vertical urbanism of the cities they inhabit. For centuries, urban conditions in most major territories were predominately defined by the street wall and the spaces it shapes. Giambattista Nolli's 1748 Map of Rome most clearly illustrates this significance and possibly solidifies what generations would understand to be the predominant urban condition. As architects, it has been a city's lower vertical wall fabric that has often been the primary focus of efforts to craft an urban experience, and for good reason. Through recent examples of built and unbuilt KPF projects, this paper will explore an upper vertical wall fabric, an urbanism that not only exists at the ground but also within the troposphere.

Keywords tall building, urban fabric, urban edge, wall, façade, troposphere

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1. Introduction

1.1. About KPF

Kohn Pedersen Fox Associates (KPF) is one of the world's preeminent architecture firms, providing architecture, interior, programming and master planning services for clients that include some of the most forward-thinking developers, corporations, entrepreneurs, and institutions in the United States and around the world. The firm's extensive portfolio spans more than 40 countries and includes a wide range of projects from office and residential buildings to civic and cultural spaces to educational facilities. Driven by individual design solutions, rather than a predetermined style, KPF's mission is to create buildings and places of the utmost quality and contextual sensitivity, providing a valuable impact on the cities they inhabit.

As a global practice with a far-reaching impact, KPF endeavors to design lasting architectural solutions that mitigate their lifecycle impact on environmental resources and that protect and enhance the well-being of the communities they serve. For that reason, the firm has joined AIA, RIBA, and many of its peers in a joint effort to develop the capabilities to design and deliver carbon-neutral buildings by 2030.

1.2 Use of Terms

For clarity, this paper utilizes CTBUH definitions and adjusts them as follows:

Tall Buildings: As there is no absolute definition of what constitutes a "tall building;" the definition is subjective. For purposes of this paper the term "tall buildings" is used when discussing any building over 150 meters (492ft) (Tall Building Criteria, 2022).

Supertall and Megatall: Tall buildings that achieve significant heights are classed in two additional sub-groups: A "supertall" is a building 300 meters (984 feet) high or higher, and a "megatall" is a building 600 meters (1,968 feet) high or higher. As of today, there are about 144 supertalls and four megatalls completed globally. There are also roughly 105 supertalls under construction. (List of supertall skyscrapers, 2022)

2. A Tall Building's Tropospheric Zone

2.1. Increasing Density

Though cities have evolved for thousands of years, it is the past 140 years where we witness the birth and, in several ways, the rebirth of the tall building. What was historically an anomaly of the urban experience has now become an integral part of the urban landscape . We have

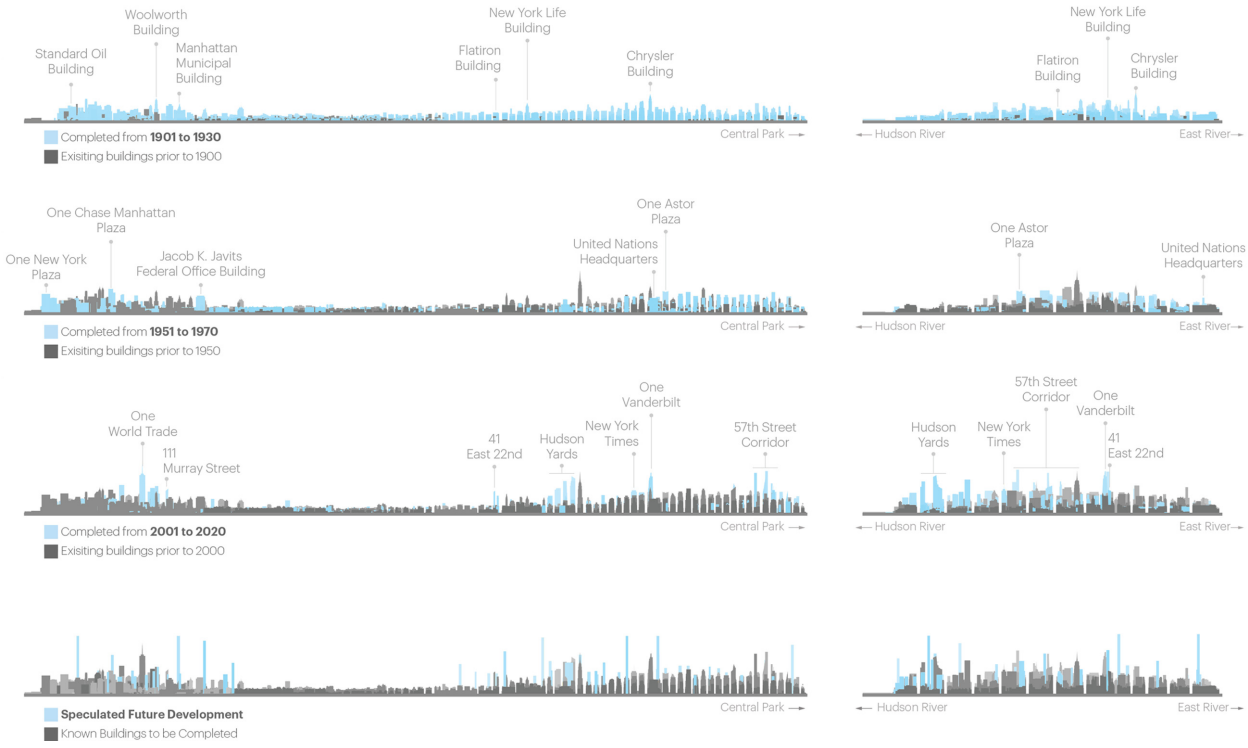


Figure 1. and 2. Courtesy of KPF. Source: Data for years 1901 to 2020 from New York City Department of City Planning "Primary Land Use Tax Output" data set, accessed 2020. 3D models from New York City Department of City Planning "NYC 3D Model by Community District." accessed 2020.

now observed a radical density increase across most global cities and with that, an increase and interest in the tall building.

To illustrate this, New York City has seen 60% growth in the number of tall towers completed in the past 30 years (1991-2021) with around 627 new tall buildings. Based on these historic patterns, we can speculate that the share of tall towers may increase by 1,286 by the year 2050 in New York City alone (Fig. 1). This trajectory can also be seen across other global cities, including Shenzhen, Mumbai and Lagos (Fig. 2).

2.2. The Troposphere

Troposphere speaks directly to the first level of the atmosphere, extending from the earth's surface to a vertical height of roughly 6 miles. In addition, it denotes a new elevated urban understanding of how populations experience density through a city's upper fabric. This includes a new responsibility for the wall of the tall, supertall, and megatall building as well as a renewed understanding of space and place within the vertical surface.

Historically, the focus on most tall buildings has arguably favored the dual terminus of base and top. This is not to suggest some of our greatest tall buildings have ignored the significance of their facade, but it is to probe that the importance of this tropospheric zone has not only profoundly increased over the past 30 years but will only continue to evolve into a more critical portion of the design of tall buildings as we further densify our urban conditions. Impacts of materiality, scale, environmental responsibility, contextual responsiveness, and place within the vertical surface have the potential to seek new meaning as we further investigate the tall building (Fig. 3).

3. The Vertical Surface- The Fabric of the Urban Troposphere

3.1. Facade Performance Responsiveness

The need to make high-rise buildings more environmentally responsive has resulted in a heightened sensitivity to the functional priorities of the exterior wall assemblies and components. This focus has become even more relevant as the building industry sets its sights on the goal of carbon neutrality.

In our current generation of work, regulations requiring greater thermal and environmental performance, which are common in many building codes around the world, are influencing our approach to façade design. High performance glass and façade shading devices, well-established measures to limit solar gain, are receiving increased emphasis in an effort to boost building performance. Additionally, window-to-wall ratios to limit the percentages of glazing and reflectivity analyses to control the wall's influence on nearby properties are influencing the next generation of exterior walls. Similarly, designers continue

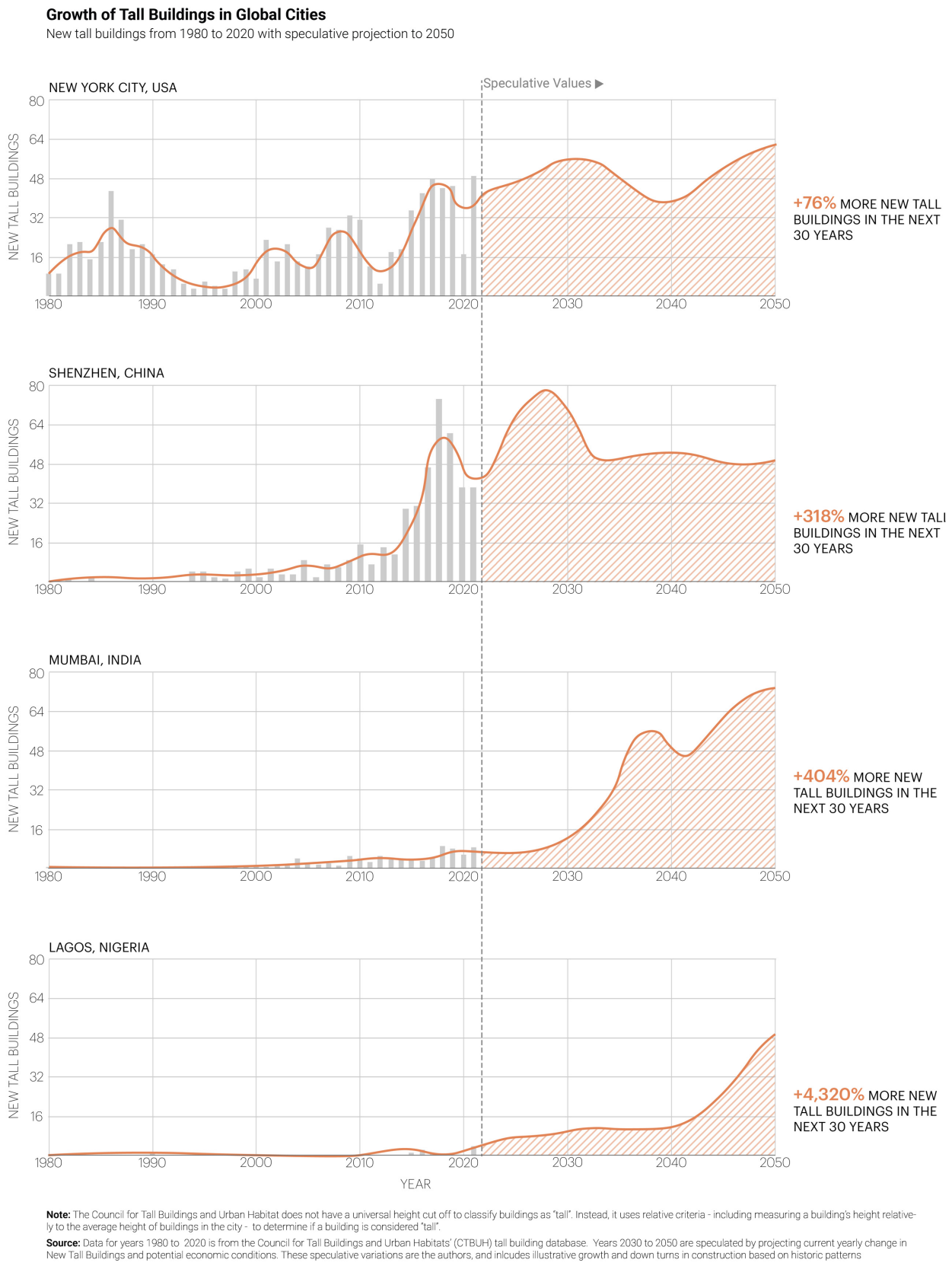


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Figure 3. Rendering by Plompmozes.

to invest efforts in sustainable material selections for the reduction of embodied carbon emissions, as well as occupant wellness strategies such as green walls, increased daylighting and light transmission, integration of natural ventilation into the wall, and even measures to minimize bird strikes.

Importantly, as we look ahead to the next generation of facades, the profession will continue to explore and integrate more advanced measures and new technologies involving such strategies as kinetic facades, electrochromatic glass, engineered timber assemblies, biomimetics, bioreactor panels, nano-turbines, PV integration, and smog eating surfaces.

All of these conditions open up opportunities to create a new level of detail and texture to the exterior wall expression and the quality of the urban troposphere (Fig. 4).

Below are a few case studies that show a shift toward a more responsive and engaged troposphere.

3.2. Solidity to Openness

The range of exterior wall strategies from the most solid to the most transparent can be seen in a number of recent projects, each with its own expressive potential.

At the more closed end of the spectrum is the wall of Spring City 66 (Fig. 5), where its solid elements bend and fold to produce a play of light and shadow. This relatively simple gesture allows for a great range of effects in daylight and the opportunity for dramatic lighting at night.

As the wall becomes more open, the use of vertical ribs or fins allows for a high degree of transparency when viewed from straight on, but collapses into a more solid expression when viewed obliquely. This allows both the transparent and solid qualities of the wall to co-exist in a dynamic relationship that changes as one moves around the building. This effect can be seen in the recent examples of the Shanghai Greenland Bund Center (Fig. 6) and the office tower in Kunming's Spring City 66 (Fig. 5).

The most exciting evolution of this progression is in transformational walls, those walls that use repetitive components in varying densities to allow them to either conceal or reveal in relation to the functions occurring



Figure 4. Photography by Mario Wibowo Photography.

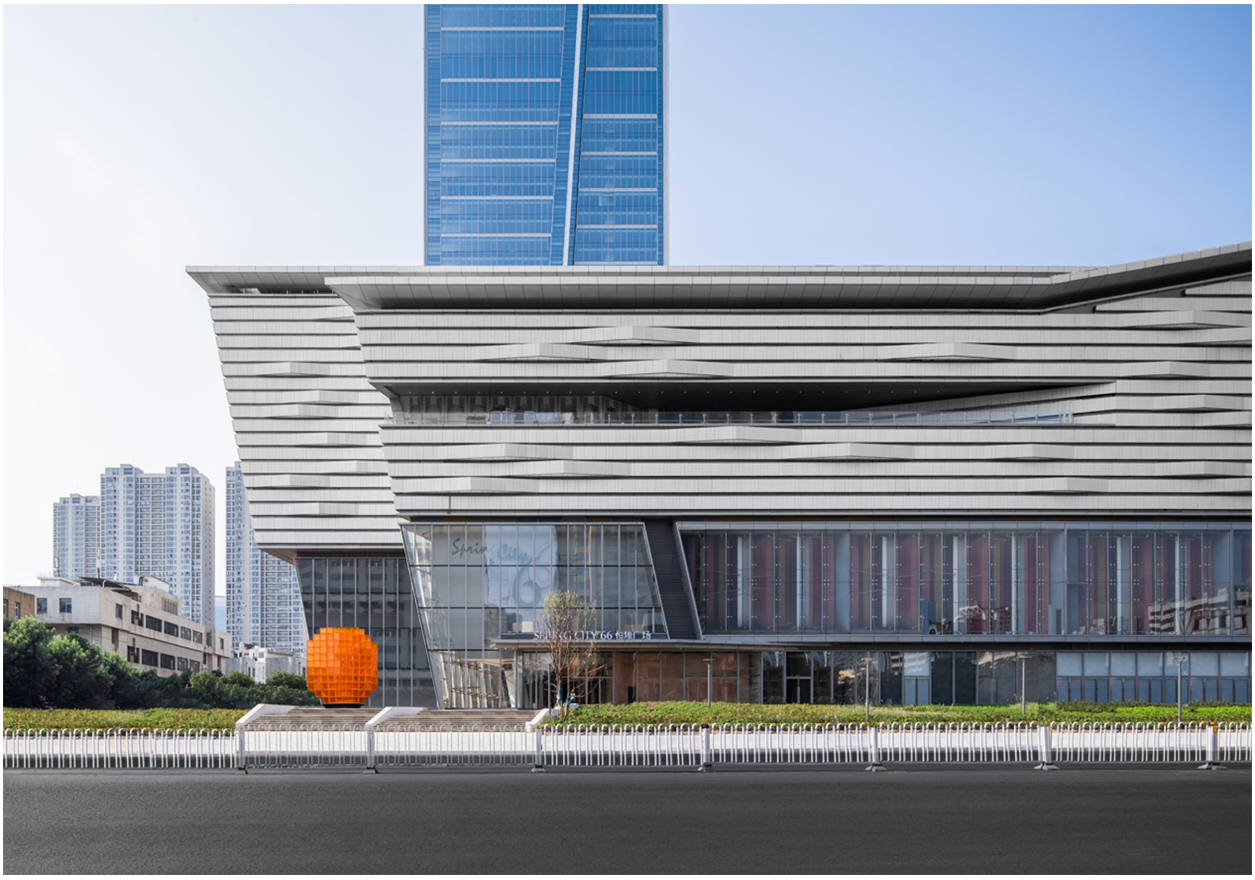


Figure 5. Photography by Ai Qing



Figure 6. Photography by Rex Zou.

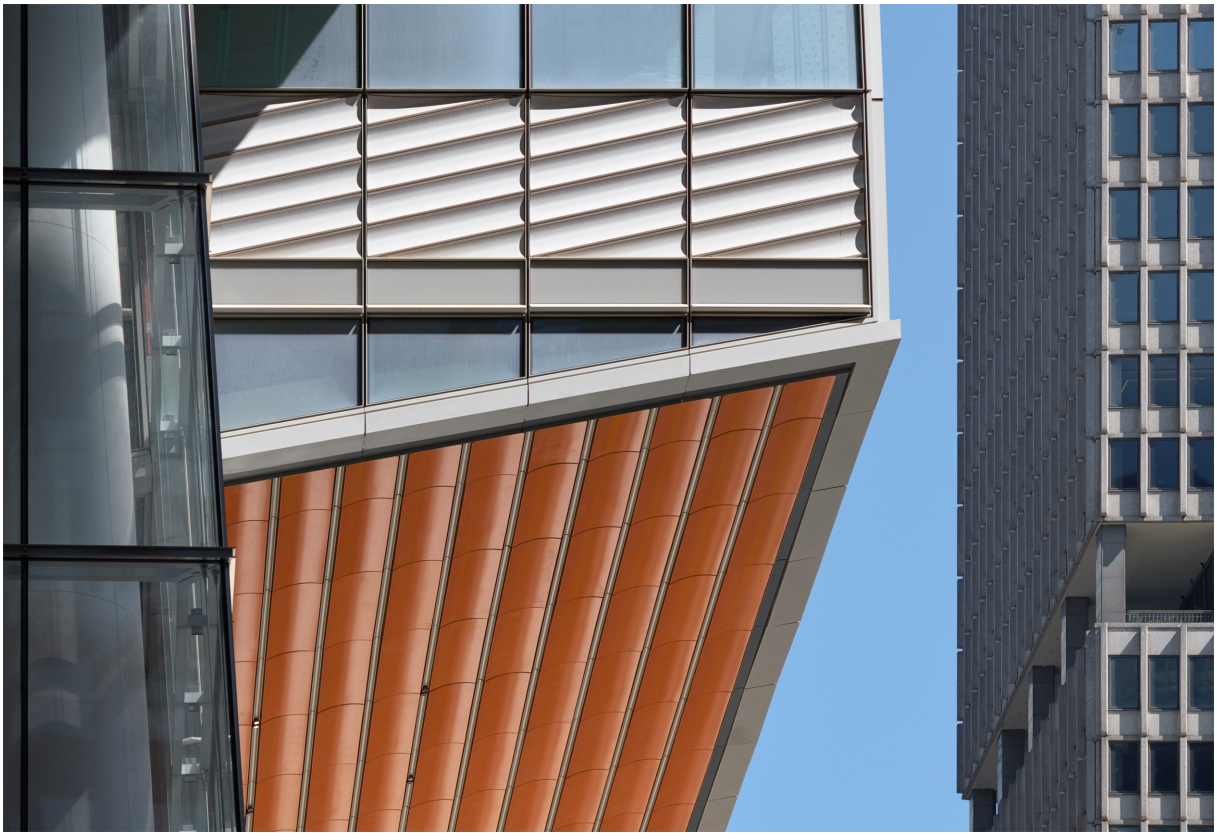


Figure 7. Photography by Raimund Koch



Figure 8. Rendering by Plomp. Courtesy of Hang Lung Properties.

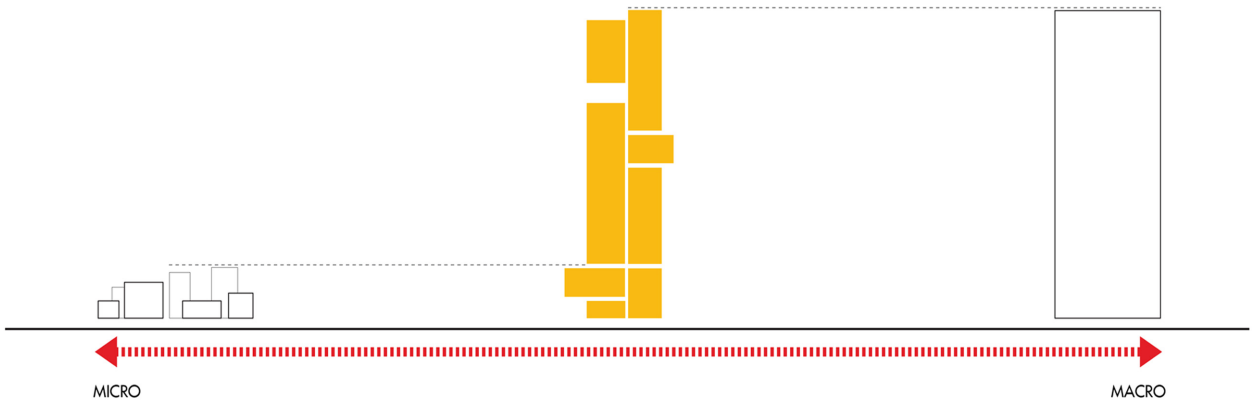


Figure 9. Courtesy of KPF.

behind the walls. Compelling examples of this are seen in the Westlake 66 (Fig. 6) project, in which both the retail podium and the towers use a variable screen strategy to achieve an unusually rich texture and a dynamic energy. This is again seen in the Sequis Tower (Fig. 4), in which projecting vertical fins are deployed in a variety of densities in response to solar orientation and massing composition.

3.3. Materiality

While aluminum, glass, and stone continue to be at the core of our exterior wall design palette, we are regularly seeking ways to embellish the fabric of the urban troposphere by exploring richer colors, textures, and materials as part of the exterior wall's components. In particular, material selections in the contemporary palette of façade systems focus more and more on the reduction of embodied carbon emissions, such as fully recycled aluminum framing, low-emission insulation, and engineered timber assemblies.

The first of two recent examples of this is the scalloped and glazed terra cotta panels on the wall of One Vanderbilt (Fig. 7), which highlight the crafted nature of the cladding



Figure 10. Rendering by Plomp. Courtesy of Hang Lung Properties.

components, make references to the local historic context, and establish a unique play of light, shadow, color, and texture. The other example is the cellular, richly profiled screen wall of the Westlake 66 (Fig. 8) retail podium, which utilizes highly chromatic and boldly shaped terra cotta window returns so that the upper podium wall animates the streetscape as much as the retail storefronts at ground level.

3.4. Occupying the Troposphere

Traditionally, public spaces in high-rise buildings were largely relegated to either the lowest or the highest floors. The desire to extend the vibrant and varied condition of the urban street to those occupying a potentially relentless



Figure 11. Rendering by Plompmozes.



Figure 12. Photography by Rex Zou.

grid of glass in the sky has driven innovation in programming of the higher floors. Now there are greater opportunities for common spaces to be arrayed throughout the building, giving occupants the ability to engage in cityscape views and activity from the mid-levels (Fig. 9). Occupied roof terraces that occur at building setbacks, such as those on Westlake 66 (Fig. 10) and the Greenland Bund Center (Fig. 12) have long been key amenities, but major public spaces are also now occurring at multiple points within the height of the building. The Sky Galleries of Zhongmao Financial Center (Fig. 11), for example, inject significant public spaces at the mid-levels of the towers.

4. Conclusion

As cities plan now for the year 2050 and beyond, the responsibility and the role of the tall building will clearly evolve. As a significant part of this evolution, the troposphere is now a new urban zone that will begin to redefine how these cities breathe as well as perform. It is in this tropospheric zone, an upper urban fabric, that the greatest potential for façade innovation and programmatic advancement lies. Tall buildings will rely on an advanced level of contextual sensitivity and thoughtfulness in their vertical expression. The use of natural light, sustainable strategies, integration of renewables, materiality, and openness of place will all reshape this fabric as we lean in towards a more intelligent and humane urban troposphere that reinvigorates our cities.

Credits

Data and Analysis by Lucien Wilson, Director, Kohn Pedersen Fox Associates PC and Eric Pietraszkiewicz, Computational Urban Designer, Kohn Pedersen Fox Associates PC.

References

Analysis for tall, Supertall and Megatall growth via CTBUH City Data

Definitions for tall, Supertall and Mega tall via CTBUH HeightCriteria (https://www. ctbuh.org/resource/height)

List of supertall skyscrapers, Wikipedia (https://en. wikipedia.org/wiki/List_of_supertall_ skyscrapers)