For more than a century, the re-creation of the urban realm in the sky through connections between buildings at height has been understood as having a vast potential for the enrichment of our cities. Whilst the world has seen a push towards greater height and urban density in our major urban centers, however, the ground level remains almost exclusively the sole physical plane of connection. As the world rapidly urbanizes, greater thought needs to be expended on how horizontal space can be developed at height, particularly as public space is increasingly at a premium, energy consumption remains high and concerns about the effects of density and isolation on physical and mental health take new precedence. Simultaneously, new transportation technologies such as ropeless elevators promise to overcome some of the logistical challenges that have held back 3-D urban development from its full potential.

This Guide, which began in the early 2000s through the PhD focus of author Dr. Antony Wood, then significantly expanded through an 18-month research project in 2018-2020, thanks to generous research funding by thyssenkrupp Elevator, is intended to provide a new generation of informed speculation on the future of the skybridge, in the context of the three-dimensional city vision. It is broken into seven chapters, each illustrated by vivid images and explanatory graphics. In the first half, it covers the early visionary conceptions and timeline of skybridge development to the present day, and examines 15 state-of-the-art modern skybridge projects in detail, subjecting these to qualitative and quantitative analysis. In the second half, cross-disciplinary considerations are provided for owner-developers, architects, engineers, and developers of skybridge-linked projects, citing exemplary current practices, concluding with potential future scenarios based on the latest visionary thinking and innovations.
# Contents

1.0 Introduction and History of Skybridges 8

2.0 Classification and Analytical Criteria 26

3.0 Case Studies 36

3.1 American Copper Buildings 38
3.2 Bella Sky 46
3.3 Concord CityPlace Parade 52
3.4 Daesung D3 City 60
3.5 Hangzhou Civic Center 68
3.6 Highlight Towers 76
3.7 Linked Hybrid 82
3.8 Nation Towers 94
3.9 Petronas Towers 100
3.10 Proximus Towers 110
3.11 Raemian Caelitus 116
3.12 Raemian Yongsan 124
3.13 Raffles City Chongqing 130
3.14 Tencent Seafort Towers 140
3.15 Torres El Faro 152

4.0 Case Study Comparative Analysis 158

5.0 Design, Management, and Operational Considerations 180

6.0 Ropeless Elevators and Skybridges 210

7.0 Conclusion: Potential Urban Futures 222

8.0 Appendices 236

Appendix A: Calculation Methodology Annex 238
Appendix B: Summary of Research Activities 242

9.0 References 250

About the Authors 255
About the CTBUH 256
Index of Featured Projects 258
Index of Companies/Practitioners 259
CTBUH Organization & Members 261
Highlight Towers
Munich, 2004

Linked Hybrid
Beijing, 2009

Nation Towers
Abu Dhabi, 2013

Daesung D3 City
Seoul, 2011

Hangzhou Civic Center
Hangzhou, 2012

Raffles City Chongqing
Chongqing, 2019

Tencent Seafront Towers
Shenzhen, 2017

Torres El Faro
Buenos Aires, 2005

Raemian Yongsan
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Shenzhen, 2017

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Buenos Aires, 2005
Background/Overview

Linked Hybrid, Beijing, sited adjacent to the old city wall, was designed as a counterpoint to contemporary urban developments in China, which tended toward isolating, singular towers behind compound walls, with few entrances. By contrast, the 600-unit residential development was designed as porous urban space, inviting and open to the public from every side. A “cinematic” urban experience of space—around, over and through multifaceted spatial layers, as well as the many passages through the project—reflect Linked Hybrid’s conception as an “open city within a city” (see Figure 3.7.1). The design of the project was intended to promote interactive relations and encourage encounters in the public spaces, with functions ranging from commercial, to educational, to recreational. The program includes a hotel, auditorium/lecture hall, museum, cinema, several cafés, and a co-working space. Linked Hybrid is among the most complex projects in this Guide, and in some ways, approaches the intricacy and richness of program that a fully realized three-dimensional city might itself achieve.

The skybridges at Linked Hybrid are critical components of the strategy of making a multi-dimensional, porous community. Their wishbone-shaped configuration was inspired by the 1910 Henri Matisse painting Dance. Connecting the predominantly residential buildings at floors 12 to 17, there are eight bridges linking nine buildings (see Figure 3.7.2); each is independently programmed with a unique function, which in some cases spills over, or is shared with a portion of the floor plate of the building to which it is attached. They embody the concept of “enclosed programmatic” skybridge, in that they serve as destinations within themselves, as much as—and in the final analysis, perhaps even more so, than—circulation.

Analysis of Skybridges

Ownership/Management

The Linked Hybrid project was developed by Modern Land (China) Co., Limited, and continues to be managed by the company. The residential portions are leased by Modern Land direct to tenants. The cylindrical Tower 0 contains a hotel, also operated under the “MoMA” brand of Modern Land. However, significant portions of the project are leased to commercial tenants, which have considerable license over the use and interior finishes of their spaces, including some of the skybridges themselves. One of the most significant tenants in this respect, a film production company called H Brothers, has taken over portions of towers 5, 7 and 8, as well as the connecting skybridges between towers 7 and 8, and between 8 and 9. This has the effect of making passage all the way through the skybridges from towers 1 through 8 impossible, as the H Brothers areas are not open to the general public or to residents of the complex (Chen & Han 2019).

Usage/Programming

Linked Hybrid encompasses a wide range of programs, even within the skybridges themselves. However, in many cases the use of each bridge is quite different from that which was contemplated at the time of design in the mid-2000s. Proceeding clockwise through the project from Tower 1, a picture of the complexity emerges.

Project Data:

Year of Completion
- 2009

Building Heights
- T1: 66 m
- T2: 66 m
- T3: 66 m
- T5: 66 m
- T6: 66 m
- T0: 45 m
- T1: 60 m
- T9: 66 m
- T0: 36 m

Number of Floors in Buildings
- T1–T9: Residual
- T0: Hotel

Type of Skybridges
- Enclosed Programmatic

Primary Functions of Skybridges
- Swimming pool, gym, cafe, gallery, lecture hall, museum, office, and meeting rooms

Number and Floor Levels of Skybridges
- Eight (8) skybridges, beginning at floor 17 in T1 and ending at floor 12 (roof level) of T0

Geographic/Climatic Data:

Geographic Position
- Latitude 39° 56’ N
- Longitude 116° 25’ E

Site Elevation Above Sea Level
- 44 m

Climate Classification
- Köppen Dwa; Hot Summer Continental Climate

Average Daytime Temperature during the Hottest Months (Jun–Aug)
- 25.9°C

Average Daytime Temperature during the Coldest Months (Dec–Feb)
- -1.1°C

Annual Average Relative Humidity
- 57.0%

Average Monthly Precipitation
- 25.6 mm

Prevailing Wind Direction
- Northwest

Average Wind Speed
- 2.3 m/s

Annual Average Daily Sunshine
- 8.9 hours

* Figure 3.7.1. Linked Hybrid was conceived as a “cinematic” experience of porous urban space, dramatically accentuated by skybridges. © Steven Holl Architects—Shu He
pass unhindered from Tower 1 all the way through to Tower 0; the team exited from Tower 5 after doubling back through Skybridge 4.

Although it was originally designed not to have a perimeter wall, the prevailing market standard for Chinese developments later demanded that one be erected. The complex overall is surrounded by a fence, and access is controlled via manned gates in four locations, some with elaborate stone towers and pagoda-like trellises defining the entrance. However, the complex remains porous in comparison to the typical Chinese residential compound, as the gates remain mostly open and seem to be something of a formality, lest access to the cinema and other public functions be hindered.

Once inside, access differs building-by-building. Each building has a set of two or three elevators serving the skybridge floors. Although the original pedestrian circulation diagram indicates that there is designated access from lobbies in three towers; 1, 5, and 6 (see Figure 3.7.9), in practice, the route to the skybridges from the ground is often not intuitive. For instance, visitors to

Figure 3.7.9. The skybridge network was designed to be accessible via public ground-floor lobbies of three of the nine towers. © Steven Holl Architects, redrawn by CTBUH

Figure 3.7.10. The skybridge system at Linked Hybrid, seen here in an unfolded section, transitions from level 18 to level 12 of the towers. © Steven Holl Architects, redrawn by CTBUH
the auditorium in Skybridge 1 pass through a café on the ground floor to the elevators, which then travel to the pre-function area at the skybridge level. In many cases, the elevator lobbies do not directly open onto the circulation path described by the route from one skybridge to the next, and one must pass through at least one set of doors to pass from the circulation path to the elevator lobby. Each skybridge can be sealed off from its connecting buildings by a set of fire curtains, lockable swinging doors, or in some cases, both.

It should also be noted that many of the bridges negotiate level changes between towers, ranging as high as level 18 and working down to level 12 (see figures 3.7.10 and 3.7.11). Some of the skybridges are ramped, but some have no way of negotiating the level changes without stairs. Although disabled access requirements are looser in many Asian countries than in the West (many ground-floor retail units have restrooms on the second floor accessible only by stairs, for instance), the intent of Linked Hybrid as a beacon of porosity seems dimmed by the excess of obstacles to smooth passage through the skybridges.

**Structural Engineering**

The general design of the skybridges is an exposed truss system with pinned diagonal struts terminating on trapezoidal flanges perpendicular to the steel H-columns, set back in a line a few hundred millimeters from floor-to-ceiling vision glass along the edge of the slab. The diagonals visible in the façade of the adjoining buildings aligns with those inside the glass-clad bridges. In many cases, the main horizontal load-bearing beams are bent or kinked in more than one dimension, typically with a bolted gusset plate, so that the floor gradually descends while widening, for instance.

Seen in a raw, unfinished state, the structural expression is handsome and lends a sense of spaciousness by pushing columns to the perimeter. However, most of the bridges are heavily modified from the original.
Analysis of Skybridges

Ownership/Management
The project was developed and operated by Singapore-based CapitaLand. Raffles City Chongqing is CapitaLand’s fourth collaboration with Safdie Architects.

Operators:
- Hotel and Adjoining F&B Outlets: InterContinental Raffles City Chongqing
- Serviced Apartments: Ascott Raffles City Chongqing
- Crystal Event Bar: Cé La Vie
- Observatory Program: Developed by National Geographic

The varying programs found in The Crystal—dining, observatory, private club with gym and infinity pool—have different management.

Usage/Programming

Skybridge 1: The Crystal
Skybridge 1 has a diversity of programming (see Figure 3.13.4). Moving from east to west, the functions include:
- An indoor/outdoor public observatory, partially located under the shelter of the arching roofline with a half-circular glass-bottom deck projecting beyond the edge of the structure;
- Four restaurants with distinguished styles, three of which offer dining along the inside curve of the skybridge, as well as upper-deck mezzanine seating;
A lushly landscaped clubhouse that includes: An infinity pool, running 57 meters along the city-facing side on the main level, and a gym on the elevated mezzanine, connected by a spiral staircase and its own elevator; Gardens with full-height trees planted in a conditioned space; A bar/event space located outdoors, under the shelter of the arching roofline, with a half-circular open-air deck projecting beyond the edge of the structure (see Figure 3.13.5).

**Skybridge 2**
Skybridge 2 is a circulation link bridge that connects the clubhouse within The Crystal to the residential lobby on the 42nd floor of Tower 3 North.

**Skybridge 3**
Skybridge 3, the larger link bridge, contains the check-in and lobby lounge of the InterContinental Hotel in Tower 4 North. The hotel extends upward from the skybridge level to the apex of the tower. The lower portion of the tower is office space.

**Access/Security**
The Crystal provides an additional level of public amenity space to the dense urban development. Given its height and sheer scale, the variety of adjacent programs in the attached towers, and the fact that—like the large urban park on the ground—it has areas that are semi-private, The Crystal requires a multi-pronged strategy for access.

Each of the four towers has at least one direct shuttle elevator to The Crystal. The public observatory is accessed...
This chapter gathers the findings of the individual case studies in Chapter 3, and subjects them to a broader analysis and commentary, organized in the same order in which the factors of analysis appear in each case study. The objective is to reach a set of broad conclusions about the state of the art in skybridge design, before moving forward into specific considerations in the remaining chapters in the Guide.

Ownership/Management

All of the projects used in case studies for this Guide are privately developed, as are the vast majority of skybridge projects around the world. In most cases, the skybridges and the projects alike continued to be managed by the company that developed them.

The most straightforward dominion over the skybridge space occurs in corporate headquarters, such as Proximus Towers (see Case Study 3.10, page 110) and Tencent Seafront Towers (see Case Study 3.14, page 140), where the entire building answers to a single party. The next-most common scenario is the speculative, multi-tenant office building, such as Highlight Towers (see Case Study 3.6, page 76), where the skybridges are a common-use facility for all tenants in the default scenario. In many cases, for the “right price,” a substantial tenant can later claim control of the skybridge if they acquire space on the same floor in two adjacent buildings. And, as has been seen in projects such as Linked Hybrid (see Figure 4.1 and Case Study 3.7, page 82), individual tenants may find the spaces desirable enough that the developer feels the tradeoff of reliable income against ease of access for other tenants is a choice worth making.

In projects with large hotel components, such as Bella Sky (see Case Study 3.2, page 46), Nation Towers (see Case Study 3.8, page 94), and Raffles City Chongqing (see Case Study 3.13, page 130), the hotel operator(s) have tended to make a significant claim on the access terms, décor and function of the skybridges. At Bella Sky, the entire project is a hotel, but at Nation Towers and Raffles City, only a portion of the towers is devoted to hotel use. At Nation Towers, the Marriott Corporation operates the skybridge as an exclusive suite of the St. Regis Hotel.

Many of the condominium and apartment towers, such as Concord CityPlace Parade (see Case Study 3.3, page 52), employ a management company that provides general maintenance and collects rents, but two independent condo organizations, one for each of the two connected towers, share responsibility for managing access to, and renting out the skybridge. A shared facilities agreement ensures continuity of operations for the bridge.

At Raffles City, the scale of the project and diversity of uses is akin to a small city, and the apportionment of management responsibilities reflects
this. The InterContinental Hotel manages the skylobby inside Skybridge 3 connecting the larger Skybridge 1 (The Crystal) to the hotel portion of Tower 4 North, but also manages food and beverage (F&B) outlets in the adjoining portion of The Crystal, in front of which hotel guests must cross on their way from the elevators. Meanwhile, the master developer, CapitaLand, has also awarded separate management contracts for the serviced apartment tower, the “event bar,” the observatory, and a private club with gym and infinity pool.

In forthcoming chapters, we discuss the implications of moving to a larger, urban scale of skybridge networks between multiple, privately-owned buildings, and the ways in which this scale change implies at least a public-private partnership in order to be workable, if not a full-scale introduction of publicly funded or operated infrastructure “in the sky.”

Usage/Programming

This is, in many respects, one of the most important aspects to evaluate in a skybridge project—how is it used, and how well is it suited for the designated purpose? Projects falling under “enclosed circulation” or “enclosed programmatic” categories will have some qualities that should be considered separately, but have just as many in common. Those skybridges whose sole function from the outset has been circulation can nevertheless be considered on the basis of the level of aesthetic quality or physical comfort provided to occupants, even if those occupants are simply “passing through.” Efforts to improve the aesthetic experience, or the physical comfort of occupants, such as implementing a design feature that spurs visual interest, or making attempts to equalize the level of the air-conditioning in the skybridge with that of the adjoining towers, might cause people to dwell in the skybridge as a point of interest or repose, thus making a “circulation corridor” a bit more “programmatic.”

As some of the more sizable case studies have demonstrated, there is practically no limit to the types of possible programming in a skybridge, should the overall project scale support it. In some projects, the placement of program “in the sky” represents bonus space that might not have been practical to create on the ground.

This was certainly reflected in intensely programmed skybridges like the “links” at Tencent Seafort Towers, where there was simply not enough buildable land to facilitate construction of a multipurpose zone that would deliver the functions of a high-amenity corporate campus to a vertical project (see Figure 4.2). Even so, the intensity of use in some of these bridges might still have been greater. Some of the double-height spaces at Tencent had projecting platforms into the void which were not utilized at the time of the Research Team visit.

Likewise, in some cases the most “special” spaces in a given project were underused, due to high fees, or the fact that plans for their use were never fully realized, leaving some “enclosed programmatic” spaces devoid of most furniture and activity. This condition was observed at Raemian Caelitus (see Case Study 3.11, page 116), for example. Others were envisioned as highly public spaces, but their desirability as real estate seems to have superseded
Figure 4.13. Each skybridge in the Guide, ranked by height of the highest occupied skybridge floor in each complex (from lowest to highest in the total collection), presented as a 2-D elevation, or "silhouette." © CTBUH

Figure 4.14. The Raffles City Chongqing "Crystal" is so long, if it were stood on end, it would nearly qualify as a "supertall" building, and would be taller than the constituent towers of all but one of the projects in the Guide. © CTBUH
a visual comparison of the huge range of scales at play in skybridges, as well as tempers expectations about how much can be done with them, especially on the smaller end of the scale, where it can be difficult to do anything more than provide a circulation corridor.

Another means of analysis revolves around the highest occupiable floor of the skybridges in each of the 15 complexes analyzed in this Guide. Figure 4.13 shows this hierarchy, proceeding from lowest (Linked Hybrid, Beijing, 53.3 meters) to highest (Raffles City Chongqing, 235 meters).

In some ways, this is an arbitrary measure, because the height of the skybridge itself, taken out of the context of its neighboring towers, let alone its greater surroundings, is not necessarily meaningful. But it is also a way to evaluate the proportions of the skybridge in context of the project as a silhouette or frame, which is a common design intent at the urban scale, and therefore meaningful from an aesthetic standpoint at minimum.

One of the most striking demonstrations of relative scale comes from turning the Raffles City Crystal skybridge on-end and placing it next to the elevations of other projects in this study (see Figure 4.14). A superlative project in every category, Raffles City’s 296-meter-long skybridge is longer than all but one of the towers in this Guide is high. Put another way, if it were turned 90 degrees and stood on one end, The Crystal would almost be a supertall building, which CTBUH defines as a building of 300 meters’ or greater height. There are only 172 supertall buildings in the world at the time of this writing. If we consider that this skybridge is a continuous piece sitting on top of four buildings which are themselves 230 meters high, in some ways then, this is the most visually arresting way to demonstrate how far the tall building community has already come in “bringing the horizontal into the vertical realm.”

All of this is not to dissemble from the importance of proportion and context, which is discussed in Table 4.2, pages 174–175. The highest and lowest values in each column are highlighted.

Discussion of Key Rankings: Table 4.2

Skybridge Statistics

Height of Highest Skybridge Above Ground Floor

As described previously, this figure is determined by measuring the lowest horizontal structural element in the given skybridge, measured from the ground floor in the overall project. Linked Hybrid’s Skybridge 1, at 50 meters above ground, is the lowest skybridge in the case study cohort,
For more than a century, the re-creation of the urban realm in the sky through connections between buildings at height has been understood as having a vast potential for the enrichment of our cities. Whilst the world has seen a push towards greater height and urban density in our major urban centers, however, the ground level remains almost exclusively the sole physical plane of connection. As the world rapidly urbanizes, greater thought needs to be expended on how horizontal space can be developed at height, particularly as public space is increasingly at a premium, energy consumption remains high and concerns about the effects of density and isolation on physical and mental health take new precedence. Simultaneously, new transportation technologies such as ropeless elevators promise to overcome some of the logistical challenges that have held back 3-D urban development from its full potential.

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