Elevated Garden Terraces &Wind Mitigation

A Case Study: Entisar Tower

Keywords:
Elevated Tree Planters
Sky Gardens
Skyscraper Terraces
Super Tall Towers
Wind Mitigation
Wind Screens
Wind Tunnel Testing

Abstract: This white paper examines AE7's use of landscape and architectural elements as a solution to the challenge of achieving proper wind mitigation in a super-tall case study, the Entisar Tower in Dubai.

1.0 Introduction:

Fig 1: Entisar Tower – Night Rendering ©AE7

Entisar Tower is a 121-floor residential tower scheduled to be completed in time for the Dubai 2020 Expo. At a height of more than 1,732 feet (528 meters), Entisar will rank worldwide among the twenty tallest towers and will be the tallest purely residential tower[1]. The exterior garden terraces are some of its most significant design features. Serving as recreational and communal spaces, outdoor terraces are located on the roofs of the parking garage and levels 7, 55, 72, 91 and 110. Each amenity landscaped terrace is unique in its layout and exposure. This presented challenges for deterring winds at minimal impact to the tower's aesthetics.

Fig 2: Level 55 Terrace ©AE7

Fig 3: Level 72 Terrace ©AE7

2.0 Design:

Elevated terraces were a part of AE7's earliest concepts of the tower, both as a means of breaking up the verticality of the massing and as a defining design feature. Very few towers showcase sky gardens exposed to the heights proposed by Entisar. For instance, at approximately 1,531 feet in height, the level 110 exterior terrace supersedes the new One World Trade Center's top occupiable floor by more than 330 feet[2] with still nine penthouse levels remaining before roof culmination above 1,732 feet. The Entisar terraces will be the tallest landscaped exterior space in the world upon completion[3]. Each of the tower's extraordinary terraces is a complement to an amenity floor lobby level, all of which service the above section of residences. Excluding level 7, every terrace features an infinity pool surrounded by trees and shrubbery. To unobstruct the view, structural ultra-clear glass construction was employed for the wind screens at all levels. Level 55 has a swimming pool with integrated palm trees dramatically accentuating the Dubai horizon. The 72nd level has a turfed area encircled by glass wind screens ideal for yoga instruction. Level 91 has a meandering pool layout set within wind blocking trees. And finally, the penthouse pool terrace on level 110 has a louvered steel trellis providing protection from wind downbursts as well as visual privacy from the penthouses above.

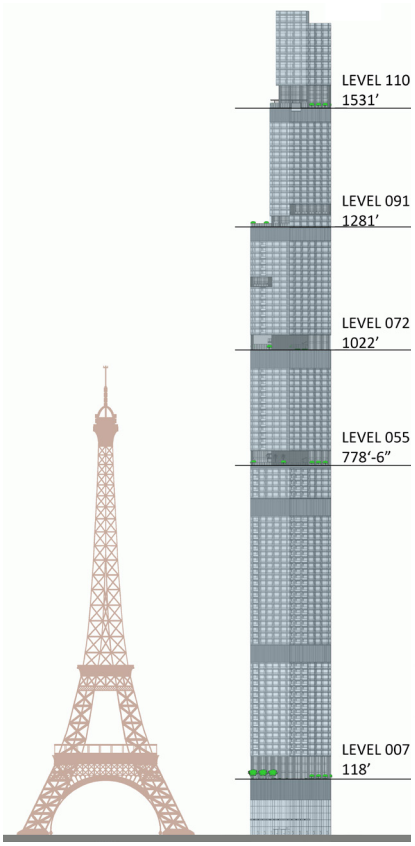

Fig 4: Terrace Height Diagram ©AE7


Fig 5: Tower Model ©AE7


Fig 6: Level 110 Terrace with Wind Trellis ©AE7


Fig 7: Level 110 Terrace with Wind Screens ©AE7

3.0 Wind:

Special wind testing is a necessary step in the early design process of a super tall tower such as Entisar. The consulting firm of Rowan, Williams, Davies & Irwin, Inc. (RWDI) worked closely with AE7 to conduct wind tunnel and other scientific tests aimed at locating areas of the tower where wind strengths could make inhabitants uncomfortable. Using 3D scale models with sensors (Figs. 8-10) and specific local wind criteria, RWDI was able to establish if an area was suitable for walking, standing or sitting. Tree canopies and windscreens were approximated by the 3D model to resolve any uncomfortable or dangerous sensor readings.

Historical wind data from Dubai International Airport helped determine wind directions and speed averages for each season (Fig. 11). Final reports found higher levels of the tower had stronger wind readings. To be comfortably occupied, the levels required further mitigation beyond the tree canopies proposed in the inital landscape design.

Large canopy trees were placed at the perimeter and corners of terraces while glass wind screen heights and widths were modified to accommodate the negative sensor readings. The architecture team also designed a steel trellis with louvers for the penthouse terrace on level 110 to withstand strong down winds from the remainder of the tower. The custom profile louvers dissipate wind while allowing scattered sunlight to filter through. Collaborating with RWDI, AE7 was able to create useful external spaces to resolve any wind issues that would affect tower residents.

Fig 8: Wind Tunnel Site Model - Courtesy RWDI

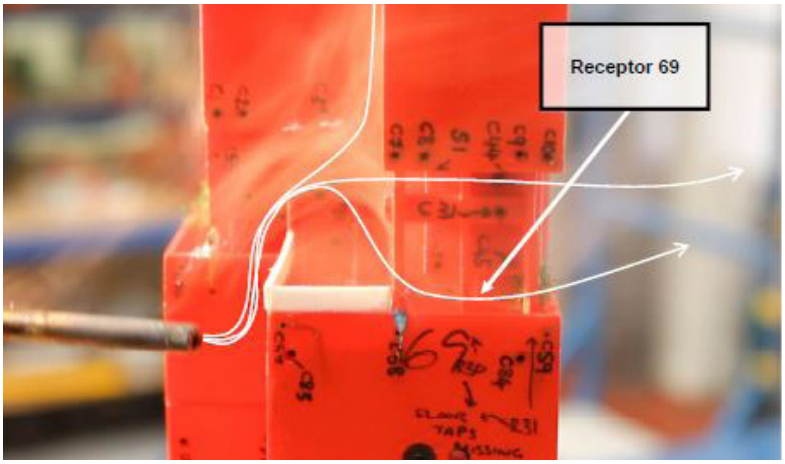

Fig 9: Smoke Pencil Test at Level 110 - Courtesy RWDI

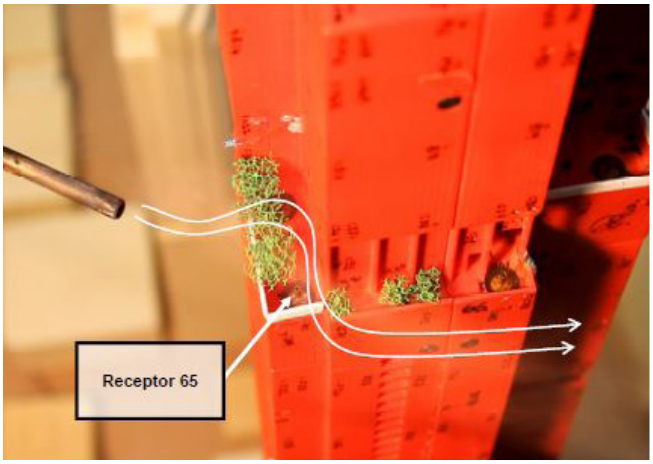

Fig 10: Smoke Pencil Test at Corner Condition - Courtesy RWDI

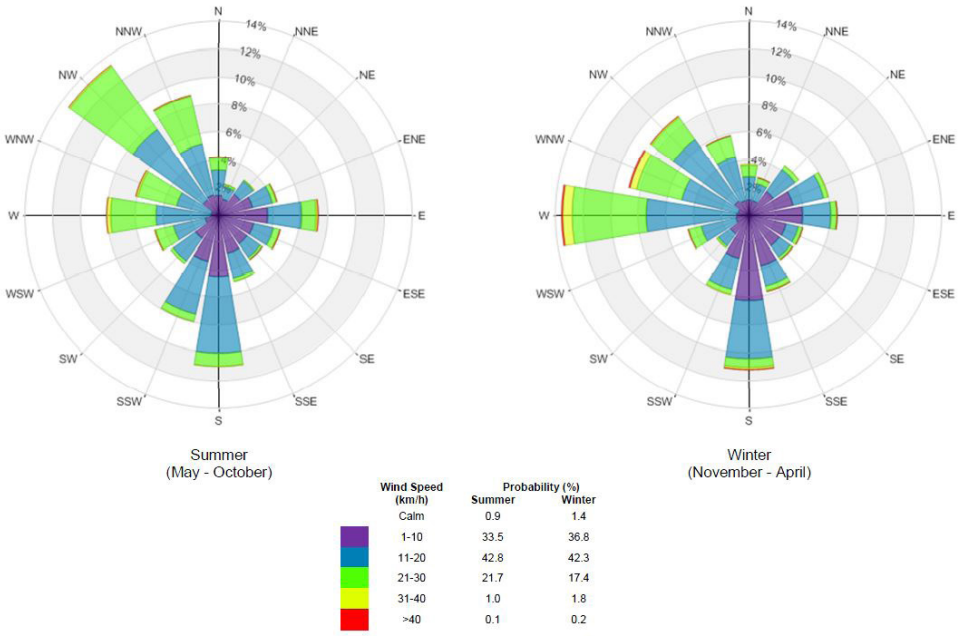

Fig 11: Dubai Airport Wind Distribution Graphs - Courtesy RWDI

4.0 Solutions:

The terrace levels proposed significant coordination challenges for the AE7 design team. Mature trees with full canopies were required which called for deep planters. It was important for the floors of the terraces to mirror the flush soffits above for the amenity levels to read as discrete subtractions from the tower. For this reason, recessed planters were engaged in the landscape design (Fig. 12). This required arduous coordination with the structural engineers, AE7 with Setec TPI of France, and the facade consultants, Inhabit Group. The tower's façade, tree planter depths, required drainage, structural thicknesses and minimum clearances for the levels beneath terraces, all vied for the same space. Careful negotiation of these areas allowed for all elements to coexist. Also, as wind speeds increased with tower height glass screens of 6.5 to 16.5 feet high were required at different terrace levels (Fig. 13). The wind screen spacing was adjusted to allow for more gaps to alleviate wind pressure. Through careful detailing the glass screens were incorporated seamlessly into the tower façade. Close collaboration bewteen the architecture and landscape departments proved extremely effective in determining and resolving these issues.

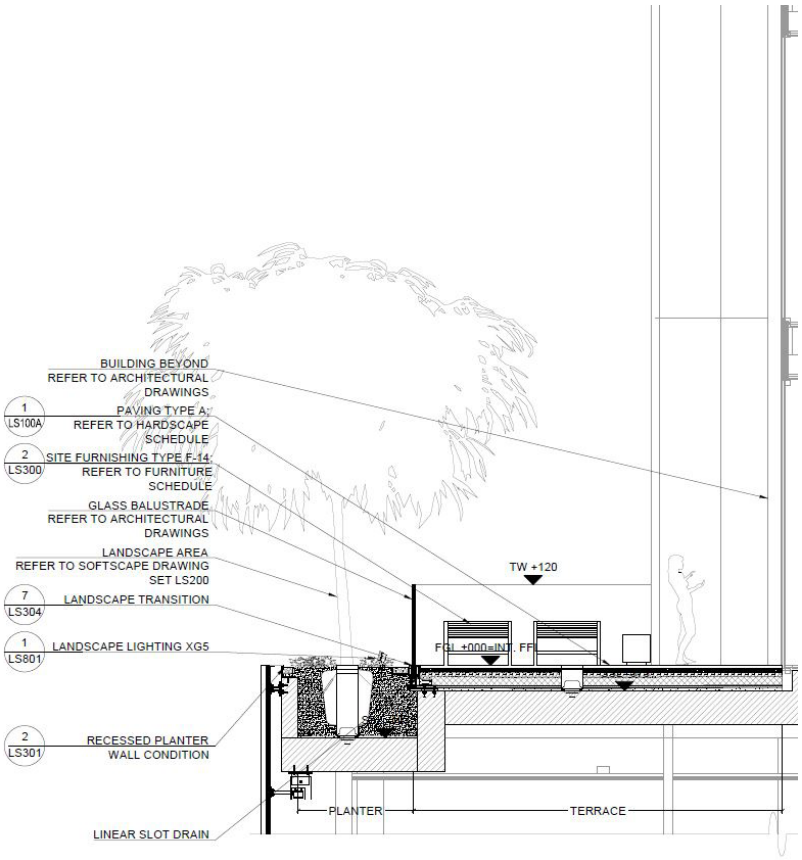

Fig 12: Recessed Tree Planter ©AE7

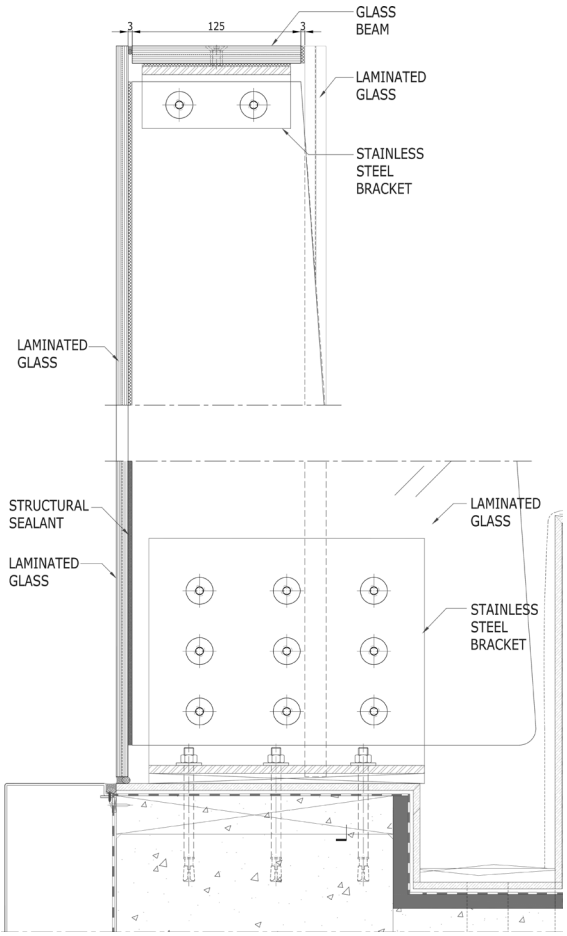

Fig 13: Wind Screen Detail - Courtesy Inhabit

5.0 Conclusions:

The design team at AE7 confronted the wind obstacles through two distinct approaches: plantings and physical architectural barriers. The use of special wind tunnel testing optimized the design and highlighted deficiencies. Unique tree planters, glass wind screens and a steel trellis mitigated the wind issues while creating custom design features. Careful coordination with technical consultants brought all elements into reality. In conclusion, Entisar Tower's terraces were successful via collaboration between landscape and architectural solutions that complemented the tower's aesthetic.

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Structural: AE7 / Setec TPI

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Date Originally Published:

March, 2016