



The One-Kilometer Tall Jeddah Tower

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Abstract

Upon completion, the construction of Jeddah Tower will represent the first man-made structure to reach one-kilometre in height. The development and proportioning of the lateral load resisting system is described and related to the architectural functionality and placed within a more general context of historical systems development for ultra-tall towers. The crucial role of wind tunnel testing and engineering for wind effects on the tower is highlighted, which along with simplicity and ease of construction, are the primary drivers for the overall design solution.

Keywords: Ultra-tall, wind engineering, bearing wall, motion perception, slenderness, vertical shortening, lateral load resistance.

1 Introduction

In early 2010, the Chicago-based team of Adrian Smith + Gordon Gill Architecture and Thornton Tomasetti as structural engineers was selected as designers of the one-kilometre tall Jeddah Tower after a long competition process involving several international firms. The winning entry was a powerful three-legged, tapering form relying on simplicity, purity and structural engineering logic to produce a highly constructible design (Figure 1). Over the following three years of collective interdisciplinary design optimization, wind tunnel testing, and independent peer review; a unique structural engineering proposal for this unprecedented, slender ultra-tall tower emerged [1].

2 Structural System Development

The program for the tower included primarily hotel and residential occupancy with a small amount of office space near the base. The combination of the desired space utilization, the preponderance of cast-in-place concrete construction in the Kingdom

and the benefits of high mass in response to the crucial issue of wind effects on the tower led to the natural selection by the design team of an all-concrete tower.

2.1 Historical Precedents

The structural system for Jeddah Tower may properly be termed a reinforced concrete bearing wall formulation. Of course the concrete bearing wall structural system has been in use for tall buildings for many decades, although the height of the Jeddah tower required an innovative solution in order to meet all of the functional, aesthetic and construction-related challenges inherent in such a project [2].

Certainly the recent Burj Khalifa tower in Dubai at over 800m in height was one tower example discussed throughout the design competition, particularly as the design architect was Adrian Smith who authored both the Dubai and Jeddah designs. There are many differences between the Burj Khalifa and Jeddah Tower structures however, not the least of which is the upper 200m of the Dubai tower is a steel framed spire [3]. Burj Khalifa