Brief on the Construction Planning of the Burj Dubai Project, Dubai, UAE

Ahmad ABDELRAZAQ
Executive Vice President
Highrise Team
Samsung C&T Corporation
Seoul, Korea
ahmad.abdelrazaq1@samsung.com

Kyung Jun KIM
Project Director of Burj Dubai & Vice President
Samsung C&T Corporation
Seoul, Korea
kjkim126@samsung.com

Jae Ho KIM
Manager at Burj Dubai
Samsung C&T Corporation
Seoul, Korea
richman@samsung.com

Summary

The Burj Dubai Project will be the tallest structure ever built by man; when completed the tower will be more than 700 meters tall and more than 160 floors. The early integration of aerodynamic shaping and wind engineering considerations played a major role in the architectural massing and design of this residential tower, where mitigating and taming the dynamic wind effects was one of the most important design criteria. While the focus of this paper will be on the construction planning of the tower, this paper will briefly present an overview of the structural system of the tower's design and construction, which are integrated from the early design concept.

Keywords: core wall system, high performance concrete, self compacting/consolidating concrete, raft foundation, wind engineering, concrete heat of hydration, creep and shrinkage, construction sequence analysis, concrete durability, cranes, hoists.

1. Introduction

Figure 1: Burj Dubai Artist's rendering

The Burj Dubai Project is a multi-use development tower with a total floor area of 460,000 square meters that includes residential, hotel, commercial, office, entertainment, shopping, leisure, and parking facilities. The Burj Dubai project is designed to be the centerpiece of the large scale Burj Dubai Development that rises into the sky to an unprecedented height that exceeds 700 meters and that consists of more than 160 floors.

The Client of Burj Dubai Tower, Emaar Properties, is a major developer of lifestyle real estate in the Middle East. Turner International has been designated by the owner as the Construction Manager, and Samsung Joint Venture (consisting of Samsung, Korea base contractor; Besix, Belgium base contractor; and Arabtec, Dubai base contractor) as the General Contractor.

The design of Burj Dubai Tower is derived from geometries of the desert flower, which is indigenous to the region, and the patterning systems embodied in Islamic architecture.

The tower massing is organized around a central core with three wings. Each wing consists of four bays. At every seventh floor, one outer bay peels away as the structure spirals into the sky. Unlike many super-highrise buildings with deep floor plates, the Y-shape floor plans of Burj Dubai maximize views and provide tenants with plenty of natural light. The modular Y-shaped building, with a setback at every seventh floor, was part of the original design concept that allowed Skidmore, Owings and Merrill to win the invited design competition.

The tower superstructure of Burj Dubai is designed as an all reinforced concrete building with high performance concrete from the foundation level to level 156, and is topped with a structural steel braced frame from level 156 to the pinnacle.

https://doi.org/10.2749/222137908796292236

The tower massing is also driven by wind engineering requirements to reduce dynamic wind excitation. As the tower spirals into the sky, the building's width and shape diminish, thus reducing wind dynamic effects, movement, and acceleration. Integrating wind engineering principals and requirements into the architectural design concept of the tower resulted in a stable dynamic response by the virtue of taming the powerful wind forces.

2. Structural System Brief Description

2.1 Lateral Load Resisting System

The tower's lateral load resisting system consists of high performance, reinforced concrete ductile core walls linked to the exterior reinforced concrete columns through a series of reinforced concrete shear wall panels at the mechanical levels. The core walls vary in thickness from 1300mm to 500mm. The core walls are typically linked through a series of 800mm to 1100mm deep reinforced concrete or composite link beams at every level. Due to the limitation on the link beam depth, ductile composite link beams are provided in certain areas of the core wall system. These composite ductile link beams typically consist of steel shear plates, or structural steel built-up I-shaped beams, with shear studs embedded in the concrete section. The link beam width typically matches the adjacent core wall thickness. At the top of the center reinforced concrete core wall, a very tall spire tops the building, making it the tallest tower in the world for all categories. The lateral load resisting system of the spire consists of a diagonal structural steel bracing system at level 156.

2.2 Floor Framing System

The residential and hotel floor framing system of the Tower consists of 200mm to 300mm two-way reinforced concrete flat plate slabs spanning approximately 9 meters between the exterior columns and the interior core wall. The floor framing system at the tips of the tower floor consists of a 225mm to 250mm two-way reinforced concrete flat plate system. The floor framing system within the interior core consists of a two way reinforced concrete flat plate system with beams.

Figure 2: Lateral Load Resisting System

2.3 Foundation System

The Tower is founded on a 3700mm thick high performance reinforced concrete pile supported raft foundation at -7.55 DMD. The reinforced concrete raft foundation utilizes high performance Self Compacting Concrete (SCC) and is placed over a minimum 100mm blinding slab over waterproofing membrane, over at least 50mm blinding slab. The raft foundation bottom and all sides are protected with waterproofing membrane. The piles are 1500mm diameter, high performance reinforced concrete bored piles, extending approximately 45 meters below the base of the raft. All piles utilize self compacting concrete (SCC) with w/c ratio not exceeding 0.30, placed in one continuous concrete pour using the tremie method. The final pile elevations are founded at -55 DMD to achieve the assumed pile capacities of 3000Tonnes. A robust cathodic protection system for both the bored piles and the raft foundation system protect the foundation systems against the severe and corrosive environment (chloride and sulfate) of the soil at the Burj Dubai site.

3. Construction of the Tower Superstructure

Currently the tower is under construction and the structure is expected to be completed by the end of 2008. In addition to the design brief described above, this paper will also include discussion about the construction of the tower superstructure such as site logistic plan, technologies used to achieve 3-day cycle, sequence of operating the ACS formwork system, Rebar prefabrication, composite link beam construction, slab formwork system and sequences of construction, planning for the concrete works, and a summary of the major equipment (cranes, hoists, and pumps, lifting of the pinnacle) used in construction the tower.