Abu Dhabi Central Market Redevelopment

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Summary

The Central Market Redevelopment, developed by Aldar Properties PJSC, consists of 700,000 square meters of new construction. The architectural design, by Foster + Partner, incorporates three tall towers (260 meter tall hotel, 380 meter residential, and a 280 meter office) surrounded by a large mixed use podium with below grade parking.

Halvorson and Partners (HP), project structural design engineers, overcame many challenges in the undertaking of this project. Construction drawings had to be completed under tightly phased deadlines in order to limit delays. The site was previously excavated and constrained by a diaphragm wall that already been constructed for a previous project design. From the beginning, HP worked in close conjunction with select specialty consultants to address the unique challenges of the UAE environment and to deliver construction drawings per the aggressive construction timetable.

Keywords: high-rise buildings; fast-track construction; reinforced concrete; core and outrigger; unbraced moment frames; corrosion protection.

1. Introduction

When Halvorson and Partners (HP) initially reviewed the Central Market site, a major redevelopment in the center of Abu Dhabi, United Arab Emirates, the design challenges appeared daunting. In May 2006, HP was appointed to complete the structural engineering of this prestigious development yet construction was proceeding on site based on a completely different project scheme. Excavation of the site was nearly complete and the developer, ALDAR Properties PJSC, requested foundation construction drawings as soon as possible to minimize the impact of the project design change to the construction schedule.

Although the new project scheme, designed by Foster + Partners (F+P), showed no resemblance to the previous design, the design team was constrained by an existing diaphragm wall constructed for the previous scheme. On-site soil and groundwater tests revealed an environment which was corrosive to the diaphragm wall tie-backs. HP realized the need to quickly resolve the unique issues of the structural design in order for structural documentation to proceed and minimize the impact to the construction schedule. HPs' primary task was to continue the steady pacing of phased structural construction drawings ahead of all other disciplines without compromising the architectural intent.

Central Market Redevelopment encompasses a footprint of over 51,000 square meters with a total area of over 700,000 square meters. Three tall towers surrounded by a large podium extend above grade. The three towers consist of a 260 meter tall 5 Star Hotel, a 380 meter tall residential tower, and a 280 m tall office tower, while the podium is comprised of an 11 story tall business hotel connected to modern retail space and a modern interpretation of an Arabian souk. A long span bridge links the retail and souk together over Sheik Khalifa Street, which splits the podium at grade. Six stories of basement serving primarily parking exist below grade.

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Fig. 1: Project Rendering (Foster + Partners)

Fig. 2: Souk Rendering (Foster + Partners)

2. Fast-Track Construction

The ambitious demand for rapid issue of piling construction drawings necessitated a quick confirmation of structural issues normally developed in Schematic/Scheme Design. Massing, structural grid, and loading criteria on the architectural scheme were established and frozen as soon as possible. HPs' teamwork with F+P identified those areas where the structural engineering needed to allow for some conservative assumptions for future architectural flexibility. Step two involved the confirmation of the structural framing system options for each project component, most importantly as they related to the assumed piling design capacities.

In the podium areas, HP developed a structural system which offered the greatest architectural flexibility. A tall story un-braced structural frame system was selected because it allowed for the maximum future flexibility of the architectural design after piles were issued for construction.

Once the podium design progressed enough to allow pile construction to commence, HP shifted its attention to completing the tower piling designs. The challenge was to complete the tower piling drawings quickly enough to keep the piling rigs on site without demobilization while allowing flexibility in the architectural design. To resist wind and seismic forces, the towers all employed reinforced concrete core walls with reinforced concrete outrigger and belt walls linked to the perimeter columns. This allowed the core and perimeter columns to resist overturning forces in addition to the gravity loads. The floor framing of three towers was then selected in order to develop the loading on the foundations. HP contracted RWDI Consulting Engineers & Scientists of Ontario to complete a Dynamic Optimization Study to more accurately study the towers should the initial wind tunnel study produce undesired results. This study permitted HP to confidently study a number of structural system revisions to the wind tunnel loading. Using this study, HP checked to ensure the effects of any structural revisions would not be detrimental to the already designed piles.

Working together, the team produced a design that avoided major construction schedule delays which easily could have resulted from switching schemes after construction had already begun. All these elements were critical to what is well on its way to becoming a world-class re-development in the center of Abu Dhabi.