Tower 114 of the King Abdullah Financial District: Analysis and Design for In-plane Forces

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Summary

This paper looks at the design of Tower 114 of the new Financial District in Riyadh, an exciting example of the growing trend amongst signature Architects to create ever more daring and dramatic building structures. The 253m high office tower is positioned at the prestigious heart of the development and is characterised by complex inclined geometry to the north facade and a dramatic 8m set-back in the south facade at level 06. The geometry of the inclined columns to the north facade creates massive horizontal in-plane forces in certain floor slabs.

The paper describes a number of structural options considered for resisting such large loads in the floors. Steel, reinforced concrete and post-tensioned concrete solutions were all considered at the concept stage. Advanced modelling and detailing techniques were used to help develop a sophisticated and effective solution to a complex engineering problem which required careful assessment of in-plane strength, stress and strain across the whole floor and at local nodes. Such a significant part of the building overall design also required careful examination of potential risks and consequent assessment of special design measures for robustness. The paper describes that the final solution adopted was via high strength steel bars within the concrete floors that offered an effective and robust solution that was easily constructed.

Keywords: Tower, outrigger, architecture, analysis, in-plane, strains, prestressing,

1. Introduction

The 253m high tower is located at the heart of the new King Abdullah Financial District in Riyadh city centre. The tower comprises 53-storey of office accommodation and a 4-storey basement that integrates the building with the surrounding car park, entertainment, and retail spaces. The main structural frame comprises reinforced concrete and structural steelwork is used for the outrigger members, located at the double height plant room at level 30.

The building is characterised by its sculptured form. The key geometric features include the complex inclined geometry to the north facade and an 8m set back at level 06 of the south elevation as shown in figure 1.

The north elevation is formed of five intersecting planes, each with a different inclination; one vertical, two leaning inwards, and two leaning outwards. The two outwards leaning planes occur between ground floor and level 14. Concrete columns frame the building edges and elevations and are located to match the architectural planes, thus being located themselves in a series of flat planes. The organisation of the structure and architecture into simple rectilinear flat, albeit inclined, façade panels offers a building that was simple to construct and clad.

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