

Design of Palm Jumeirah Monorail

Sopon Ritdumrongkul

Design Engineer
Norconsult Civil Engineering Co.Ltd.
Bangkok, Thailand
sopon@norconsult.co.th

Worapatt Ritthichauy

Design Engineer
Norconsult Civil Engineering Co.Ltd.
Bangkok, Thailand
worapatt@norconsult.co.th

Knut Hj. Nielsen

Executive Director
Norconsult Civil Engineering Co.Ltd.
Bangkok, Thailand
nielsen@norconsult.co.th

Hideya Omi

Project Director
Obayashi Corp.
Tokyo, Japan
omi.hideya@obayashi.co.jp

Summary

The Palm Jumeirah monorail is connecting the artificial Palm Jumeirah Island to the mainland of Dubai in the United Arab Emirates. The design methodology of the monorail structures was developed to accommodate the unique features of transit guideway structures, durability and constructability. An efficient continuous frame system monolithically integrated with the columns was therefore utilized. The 5.45 km long monorail line typically includes 29 m long guideway beams continuous over 5 spans. Over marine sectors and some other locations long span bridges are used with superstructure designed as a special cast-in-situ sandwich beam. The monorail structures were designed in Thailand by Norconsult Civil Engineering, Co. Ltd., the civil contractor is Palm Jumeirah Monorail Civil Joint Venture, a group of Japanese contractors, and Nakheel is the project owner. Construction began in March 2006 and opening is scheduled in April 2009.

Keywords: monorail; Palm Jumeirah; guideway beams; long span bridges.

1. Introduction

The Palm Jumeirah Island (*Fig. 1*) is the first among three artificial palm islands (Palm Jumeirah, Palm Jebel Ali and Palm Deira). It is extended into the Persian Gulf from the Jumeirah coastal area of the emirate of Dubai in the United Arab Emirates. The island is shaped like a palm tree. It consists of a trunk, a spine, fronds and a crescent island. The Palm Jumeirah will feature hotels, resorts, villas, apartment buildings and retail outlets, including the Atlantis Hotel on the Crescent.

Transportation to the island can be made by cars as well as public transportation, the Palm Jumeirah monorail. The 5.45 km long monorail line connects mainland with the island by crossing the sea at Marine Sector 1. It then runs through the centre of the Trunk and Spine areas before crossing the sea again at Marine Sector 3 to connect with the Atlantis Hotel on the Crescent.



Fig. 1: The Palm Jumeirah Island (March 2007)

The monorail line consists of typical structures, long span bridges and a switch platform bridge. The typical structures are mainly applied along the Trunk and Spine areas with typical 29 m long guideway beams continuous over 5 spans. Where longer spans are required, as in the marine sectors, Trunk area and a few other places, special cast-in-situ structures are applied. The switch platform bridge is a platform structure upon which guideway beams and switching devices are installed. The monorail structures are supported by bored piles down into rock at approximately 30 m below ground level.

The Palm Jumeirah monorail project is a design-built project owned by Nakheel with project budget US\$400 millions. The civil contractor is Palm Jumeirah Monorail Civil Joint Venture, a group of Japanese contractors led by Obayashi Corp. Designer of the monorail structures is Norconsult Civil Engineering Co. Ltd. The design is done in cooperation with Dr. Charles Dolan, University of Wyoming. Detailed design began in January 2006 and construction started in March 2006.

2. Design Methodology

The design methodology for structural members supporting the monorail complies with the Employer's Requirements, BS 5400, the standard specifications of AASHTO for seismic loads, JAFZA's guideline for wind loads and the CIRIA Publication C577 for durability. It is developed to suit the unique features of transit guideway structures, such as guideway-vehicle interaction, special fatigue requirements, performance, cost efficiency, minimum urban and traffic disruption during construction, and above all constructability and structural efficiency. It also aimed at achieving robust, durable structures of which minimal maintenance will be required.

3. Structures

The typical structures (*Fig. 2*) are applied for more than 80% of the project, mainly along the centre of the Trunk and Spine areas. While the monorail was built, work was underway on all other parts of the Palm. Constructability and minimal disruption of traffic during construction are therefore the main requirements for its structural form and construction method. A frame system constituted by precast beams monolithically connected with cast-in-situ columns was selected. Durability is also enhanced by using monolithic connection instead of bearings. Typical structure contains 5 x 29 m spans continuous. Large diameter bored piles are adopted for the foundation system. Pile caps and columns are cast-in-situ reinforced concrete members. Precast beams constitute the typical superstructure, made monolithic with columns by stitch joints between beams and top of the columns. Continuity of the frames is enhanced by continuous prestressing tendons over the joint.



Fig. 2: Typical span structures

Long span bridges are applied in the marine sectors, Trunk area and a few other places. These structures are also designed as continuous frames monolithically integrated with the columns. The superstructure consists of a cast-in-situ prestressed supporting beam with variable depth, upon which the guideway beams are installed and prestressed. The two structures are then combined into a final composite sandwich structure by a cast-in-situ intermediate concrete pedestal. Maximum span length of the long span bridges is 60 m.

The switch platform bridge is a cast-in-situ prestressed concrete bridge serving as a platform upon which guideway beams and switching devices are installed. The guideway beams are installed on reinforced concrete plinths rigidly integrated with the bridge deck. Stitch joints are cast to provide monolithic connection and then continuous prestressing tendons over the joints are applied.

4. Conclusions

The Palm Jumeirah monorail serves as the public transportation system for the Palm Jumeirah Island. The monorail structures consist of typical span structures, long span bridges and a switch platform bridge. They were designed by using a framing system to accommodate the unique features of transit guideway structures, durability and constructability. The construction of the monorail structures was completed in July 2008. The monorail is scheduled to open in April 2009 with a capacity to transport 40,000 people each day.