PC Structures Used in the New Runway of Haneda Airport
— Tokyo International Airport D Runway Construction Project —

羽田空港新滑走路に適用された PC 構造物
— 東京国際空港 D 滑走路建設工事 —

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Synopsis
The fourth runway (D Runway) at Tokyo International Airport (Haneda Airport), which is one of the largest airports in the world in terms of the number of passengers handled, was completed in August 2010. As D Runway was constructed in the mouth of the Tama River, it was built as a hybrid structure using a pile-elevated platform and land reclamation (**Fig. 1**). In the construction of D Runway, it was necessary to meet such requirements as structural safety under aircraft loads, long-term durability (design service life of 100 years) and rapid construction within just 41 months. Therefore, various precast prestressed concrete structures were adopted throughout the D Runway construction project.

Fig. 1 Haneda Airport D Runway

Structural Data
(1) Project outline
Owner: Kanto Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism
Type of contract: Design-and-build contract
Design and construction: Joint venture involving Kajima, Aomi, Obayashi, Penta-Ocean, Shimizu, Nippon Steel Engineering, JFE Engineering, Taisei, Towa, Toyo, Nishimatsu, Maeda, Mitsubishi Heavy Industries, Mirai, and Wakachiku
Construction period: Mar. 29, 2007 – Aug. 30, 2010
Construction site: Ota-ku, Tokyo

(2) Pile-elevated platform
Dimensions: 1,100 × 524 [m] (area: approximately 52 ha)
Substructure: Steel jackets (n = 198) and steel pipe piles (n = 1,165)
Superstructure: Composite structure of steel I-girders and concrete deck
Decks: Precast prestressed concrete slabs (6.6 × 3.3 [m], approx. 10,700 slabs) and UFC slabs (7.8 × 3.6 [m], approx. 6,900 slabs)

(3) Connecting structure between reclamation area and pile-elevated platform
Dimensions: 428.7 × 14.4 [m]
Substructure: Steel-pipe sheet-pile cellular foundation

Superstructure: Slit-type wave-breaking seawall
(Precast 1,200-mm dia. PC columns, n = 229)

(4) Connecting taxiway bridge

Dimensions: length 620 m; width 63 m
Substructure: Steel-jacket foundation and steel-pipe piles
Superstructure: Four-span continuous steel I-girder and precast concrete deck composite structure (bridge section)
Precast prestressed concrete girder-slab structure (pier section)

1. Introduction

Precast prestressed concrete structures were adopted throughout the construction of D Runway in order to meet such requirements as structural safety under aircraft loads, long-term durability (design service life of 100 years), and rapid construction within 41 months. This paper describes the precast concrete deck used in the pile-elevated platform, PC columns in the wave-breaking seawall at the connecting structure, and the prestressed girder-slab structure on the connecting taxiway bridge.

2. Deck of Pile-elevated Platform

(1) Structure of Pile-elevated Platform

The structure of the pile-elevated platform is shown in **Fig. 2**. The precast concrete deck was mounted on steel I-girders (grid girders) above steel jackets supported by steel pipe piles. Across the total 52 hectares of the pile-elevated platform, precast prestressed concrete slabs (PCa slab, $f'_{ck} = 50$ N/mm^2) were used for the runway and taxiway area (31 ha), and Ultra high-strength Fiber-reinforced Concrete (UFC) slabs were used for the remaining 20 hectares (**Fig. 3**). The decks were designed to carry the load of aircraft weighing up to 400 tons.

(2) Precast Concrete Deck (PCa Slab)

PCa slabs were created by installing slabs on the steel I-girders, then casting filling concrete into the gaps between the slabs to form a continuous concrete deck structure with no structural joints. Stud dowels were attached to the upper flanges of the steel girders parallel

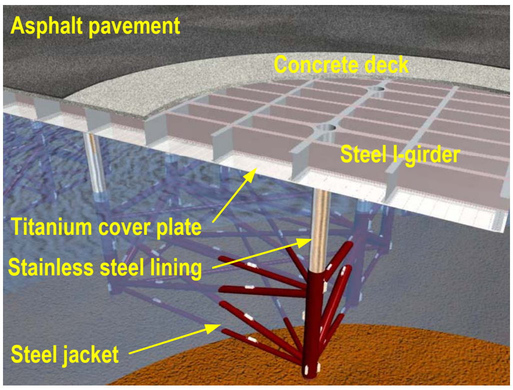

Fig. 2 Structure of pile-elevated platform

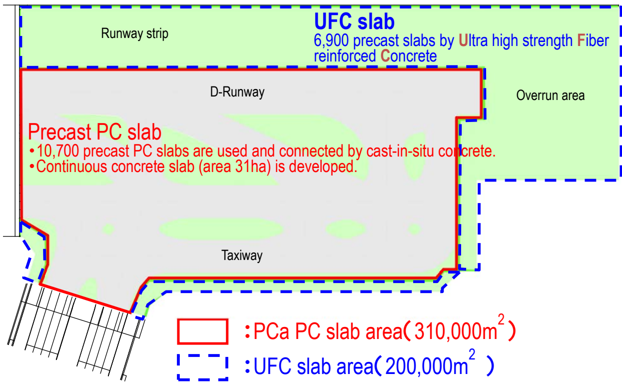

Fig. 3 Installation area of precast concrete slabs

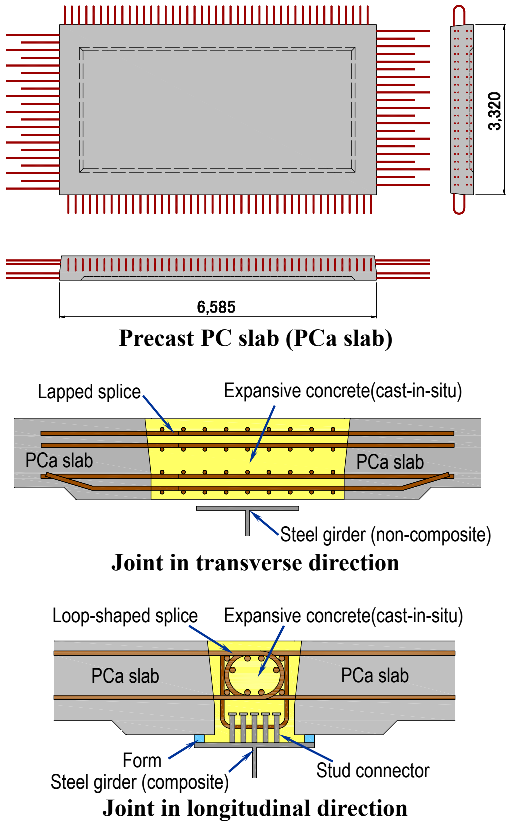

Fig. 4 Connecting structure between concrete slab and steel girder

to the runway for connection to the PCa slabs (**Fig. 4**). Since a large negative bending moment occurred above the legs of the steel jacket, the PCa slabs around the leg were stressed for reinforcement using the post-tensioning method at the site.

PCa slabs need to have long-term durability against the fatigue induced by the cyclic loading of aircraft over a service life of 100 years. They were therefore designed to restrain cracks in the gap-filling concrete to widths of less than 0.2 mm. The structural safety and durability of the gap-filling concrete were verified in static and fatigue loading tests.

A production plant which could manufacture 24 PCa slabs a day was developed for the project. A total of 10,697 slabs were manufactured in 25 months. The PCa

Fig. 5 PCa slab production plant

Fig. 6 Installation of PCa slabs

slab production plant is shown in **Fig. 5** and installation of the PCa slabs on the pile-elevated platform at the site is shown in **Fig. 6**.

(3) UFC Slabs

UFC slabs were adopted for the runway strip and overrun area where airplanes do not generally run. Since UFC slabs had a compressive strength of 180 N/mm^2 greater than ordinary concrete slabs and slab weight reduction was possible compared to normal concrete, the quantity of steel required for the substructure (steel pipe piles and steel jackets) could be reduced. The structure of the UFC slabs is shown in **Fig. 7**. The UFC slabs were also manufactured at special production plants, transported to the site on barges, and installed on the pile-elevated platform. The UFC slab production plant and installation at the site are shown in **Fig. 8**.

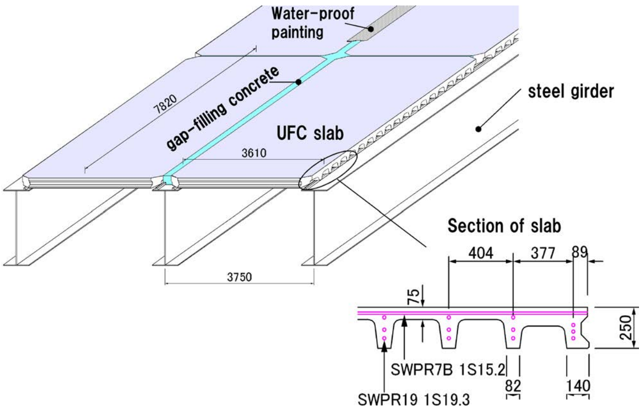

Fig. 7 Structure of UFC slab

Fig. 8 Construction of UFC slabs

3. Connecting Structure between Land Reclamation Area and Pile-elevated Platform

The connecting structure between the land reclamation area and pile-elevated platform is shown in **Fig. 9**. A slit-type wave-breaking seawall was constructed on the steel-pipe sheet-pile cellular foundation to prevent reflection waves during storms from affecting the superstructure of steel jackets. Precast prestressed concrete columns ($f'_{ck}=80$ N/mm^2) of 1,200-mm diameter were arranged with 600-mm slits between columns. Reflection waves were reduced as the energy of the waves was absorbed as they passed through the slits. Construction of the precast PC columns for the wave-breaking seawall is shown in **Fig. 10**.

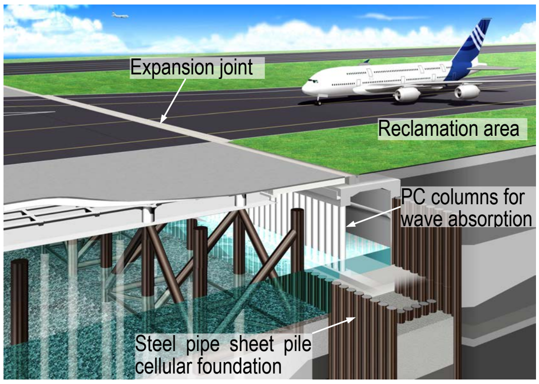

Fig. 9 Structure of connection

Fig. 10 Construction of wave-breaking seawall

Fig. 11 Installation of expansion joint

Since the reclamation area and pile-elevated platform behaved differently due to temperature changes and earthquakes, expansion joints were installed on the connecting structure to absorb the different movements of the structures (**Fig. 11**). The expansion joints allow for relative displacements of ±60 cm in both longitudinal and transverse directions.

4. Connecting taxiway bridge

The two aircraft-capable connecting taxiway bridges are 620 meters long and 63 meters wide connecting the existing airport facilities to the D Runway (**Fig. 12**). The connecting taxiway bridges include a 260-meter-long bridge section under which small vessels can pass, and a 360-meter-long pier section constructed as a PC girder-slab structure.

(1) Bridge section

The bridge section is a four-span continuous girder bridge (44+70+70+44 [m]) formed as a steel-concrete composite structure with steel I-girders and PCa slabs. The substructure is composed of jacketed foundations supported on steel pipe piles.

(2) Pier section

In the pier section, which is in part of the connecting taxiway bridge nearer to the existing airport, the

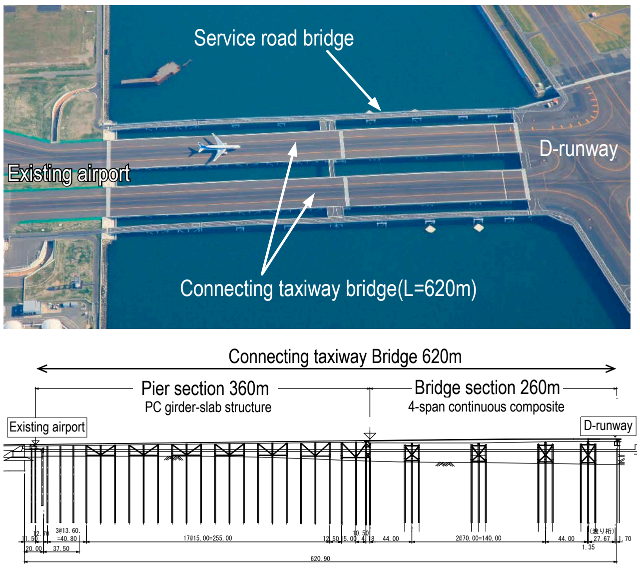

Fig. 12 Connecting taxiway bridge

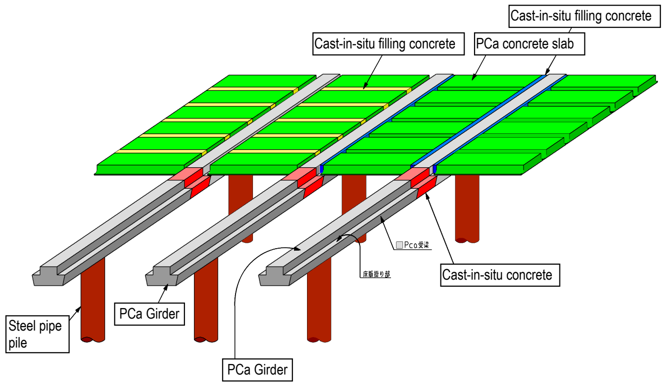

Fig. 13 Prestressed concrete girder-slab structure

Fig. 14 Construction of PC girder-slab structure

superstructure is lower and closer to sea level. In the superstructure, therefore, a precast prestressed concrete girder-slab structure was adopted to ensure stability against the uplifting force of waves and durability against corrosive marine conditions (**Fig. 13**). The superstructure was divided into load-bearing main girders, cross girders and slabs, which were all made by precast prestressed concrete. Large girder erection cranes, which could travel transversely, were used to erect precast girders (**Fig. 14**).

5. Closing remarks

The construction of the pile-elevated platform, connecting structures and connecting taxiway bridge for the D Runway at Haneda Airport was rapidly completed by actively using prestressed concrete members. Three years have passed since D Runway came into service in October 2010, and it experienced the massive earthquake of March 11, 2011 but has remained in service without any serious problems.

概　要

2010年８月に東京国際空港（羽田空港）の沖合いに建設された４本目の滑走路（D 滑走路）では，建設地点が多摩川の河口に位置することから，川の流れを阻害しないように桟橋工法と埋立工法を組合せたハイブリッド構造が採用されている。この D 滑走路の建設において，航空機荷重の作用に対する構造安全性の確保と設計耐用年数100年間の耐久性の確保，さらには41か月という短工期での建設可能な施工方法といった点から，プレキャスト PC 構造物が随所に用いられている。

本報告では，D 滑走路に適用された PC 構造物のうち，桟橋部のプレキャスト床版（PCa 床版，UFC 床版），埋立／桟橋接続部の消波護岸，ならびに連絡誘導路橋の PC 梁スラブ構造等の概要や施工実績について紹介する。