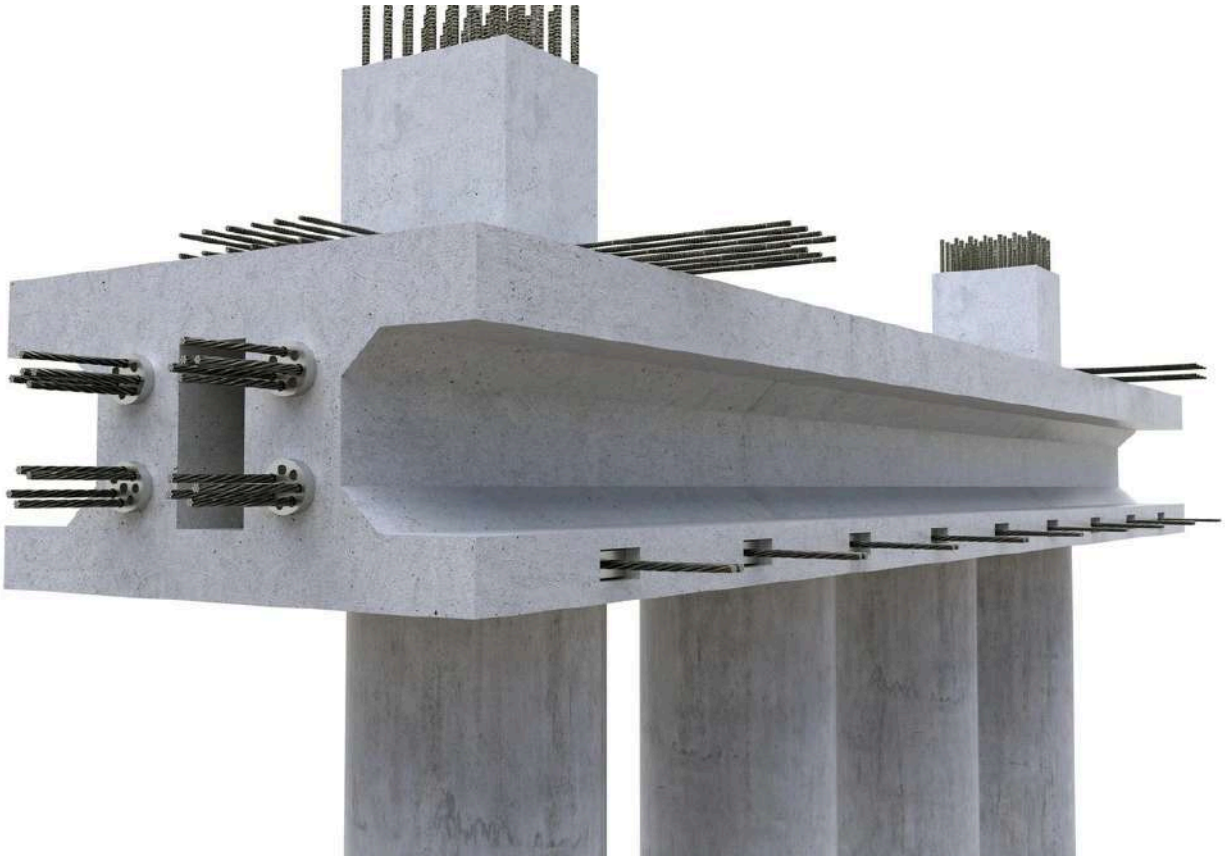
Long-Span Residential Architecture in Tropical Environments: Sun Diego Resort Villa Pattaya Case Study

Architectural White Paper

Structural systems, environmental performance, and spatial configuration in Pattaya, Thailand



Analytical drawing of the post-tensioned foundation system showing tendon layout, anchorage zones, and structural configuration.

Executive Summary

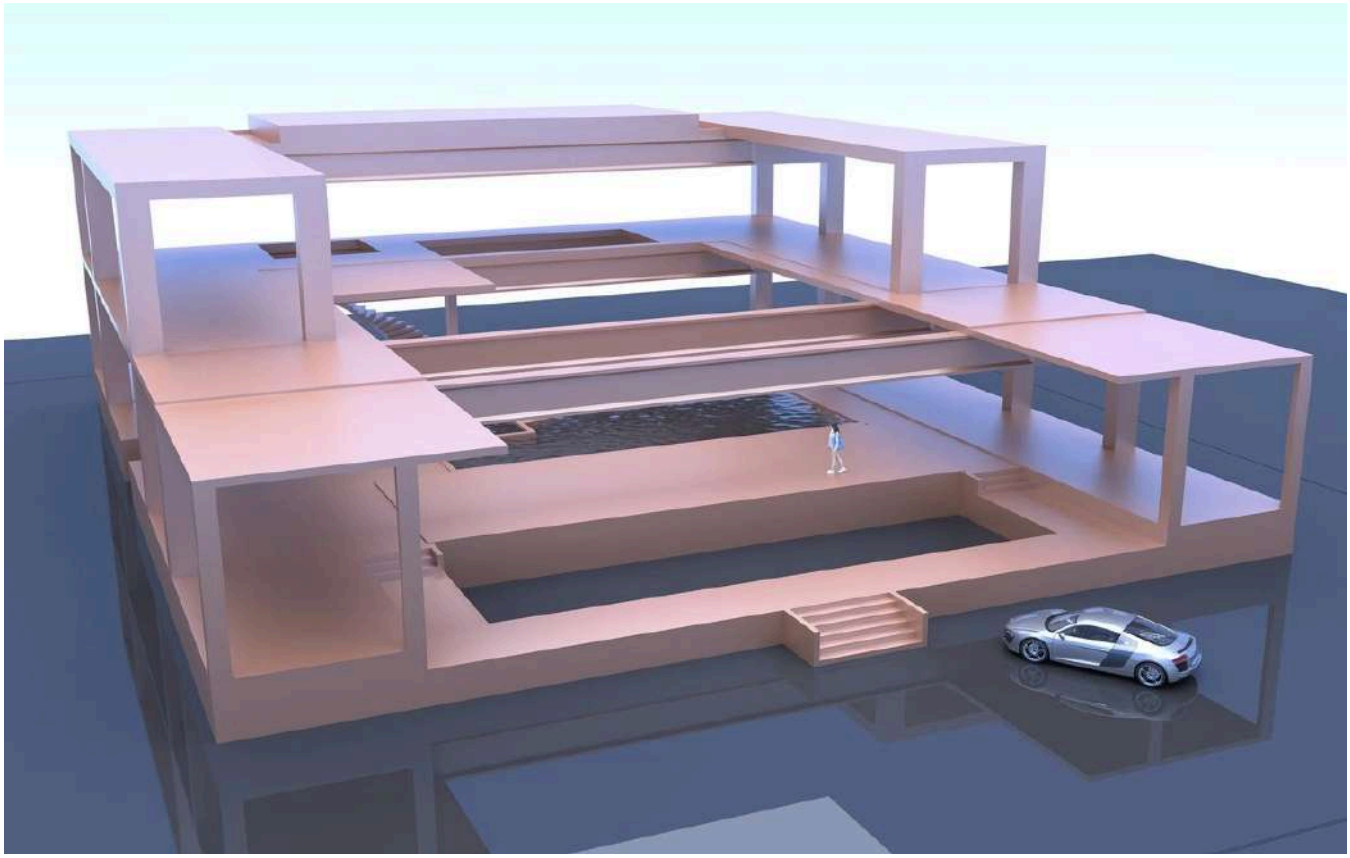
This white paper investigates long-span residential architecture in tropical environments through the case study of **Sun Diego Resort Villa Pattaya**. It analyzes structural performance, spatial configuration, and environmental adaptation within a hybrid system combining reinforced concrete, post-tensioned concrete, and steel cellular beams.

tropical conditions.

Key objectives include:

1. Assessing the effectiveness of long-span structural systems in reducing internal supports while maintaining structural stability.
2. Evaluating spatial continuity, interior flexibility, and the integration of indoor–outdoor transitions in tropical climates.
3. Documenting construction methodology and material performance under local environmental conditions.

Findings indicate that hybrid long-span systems can provide extended spans of up to 30 m, reduce column density and support open-plan interior layouts while maintaining structural performance. Observations also highlight coordination requirements, cost implications, and material considerations critical to performance in humid tropical climates.



Integrated architectural and structural diagram of Sun Diego Resort Villa Pattaya, illustrating the relationship between long-span structural elements, primary load-bearing systems, and spatial configuration.

Problem Statement

Conventional residential construction in tropical climates typically relies on reinforced concrete systems with dense column grids. These systems constrain spatial continuity, limit natural

Long-span structural systems provide an alternative approach by reducing internal load-bearing elements. However, these systems introduce increased structural complexity, coordination requirements, and cost implications, necessitating integrated architectural and engineering design strategies.

Application: Sun Diego Resort Villa Pattaya

The following sections document **Sun Diego Resort Villa Pattaya** as the primary case study used to examine the architectural and structural responses to the conditions outlined above. The project is evaluated in terms of system selection, construction methodology, and observed behavior within a tropical context.

Project Type: Private Residence · Status: Completed · Category: Built Work

Prepared as part of an architectural and structural case study. Structural review conducted by a licensed engineering consultant in accordance with Thai engineering standards.

- Architect, Structural Designer & Developer: Mario Kleff
- Licensed Engineering Consultant (Thailand): Dr. Songkiat Matupayont
- Main Contractor: Wandeegroup Asia Co., Ltd.
- Post-Tensioning Contractor: Span Systems International Co., Ltd.
- Steel Fabrication (Cellular Beams): B.S.Y. Construction Co., Ltd.
- Pattaya, Chon Buri, Thailand · Completed 2025
- Design Standards: Thai Building Control Act B.E. 2522; Engineering Institute of Thailand (EIT) guidelines

The project employs a hybrid structural system combining reinforced concrete, post-tensioned concrete, and steel elements with integrated cellular beam technology. The structural design framework follows the Thai Building Control Act B.E. 2522 and applicable engineering standards of the Engineering Institute of Thailand (EIT).

The project is evaluated relative to conventional reinforced concrete construction methods commonly used in residential developments in Thailand, particularly in terms of span configuration, structural integration, and construction methodology.

Contents

Author & Authority

Mario Kleff is identified as the architect overseeing the design and development of the project, including coordination of architectural and structural systems.

Licensed Engineering Consultant: Dr. Songkiat Matupayont, providing structural verification and ensuring compliance with applicable Thai engineering standards.

Disclosure and Verification Statement: The author served as architect, structural designer, and developer for this project. Structural design elements were reviewed by a licensed engineering consultant in Thailand for compliance with applicable codes and standards. The consultant's review was limited to technical verification of structural design and did not extend to authorship of this document. All content and conclusions presented herein remain the responsibility of the author.

Document Information

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- Subject: Sun Diego Resort Villa Pattaya

Sun Diego Resort Villa Pattaya (formerly Lieb Tang Rodfai Villas) is a multi-villa residential development in Pattaya, Thailand. The project was delivered under a unified design–build framework combining architectural and structural responsibilities. Planning commenced in 2022, with phased construction between 2023 and 2024, public opening in 2024, and completion in 2025.

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1. Project Facts

Official Name	Sun Diego Resort Villa Pattaya
Former Name	Lieb Tang Rodfai Villas
Type	Multi-villa residential development with integrated functions
Architectural Firm	Mario Kleff® Architects Co., Ltd.
Structural Designer	Mario Kleff
Engineering Consultant	Dr. Songkiat Matupayont
Developer	Mario Kleff
Main Contractor	Wandeegroup Asia Co., Ltd.
Location	Pattaya, Chon Buri, Thailand
Address	171/171 Moo 12, Nong Prue Subdistrict, Bang Lamung District, Chon Buri 20150, Thailand
Urban Context	Low-density residential zone
Coordinates	12.88387° N, 100.90185° E
Planning Year	2022
Public Opening	2024
Completion	2025
Villa Size Range	Approximately 680–1,650 sqm
Development Scale	Multi-villa residential development
Development Type	Residential development with integrated hospitality functions

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The project is located in Nong Prue, Bang Lamung District, Chon Buri Province, Thailand, in proximity to Sukhumvit Road, Chaiyaphruek 2 Road, and Lieb Tang Rodfai Road.

This location provides access to central Pattaya while maintaining spatial separation from higher-density urban zones. The surrounding context is characterized by low-density residential development with emerging mixed-use activity.

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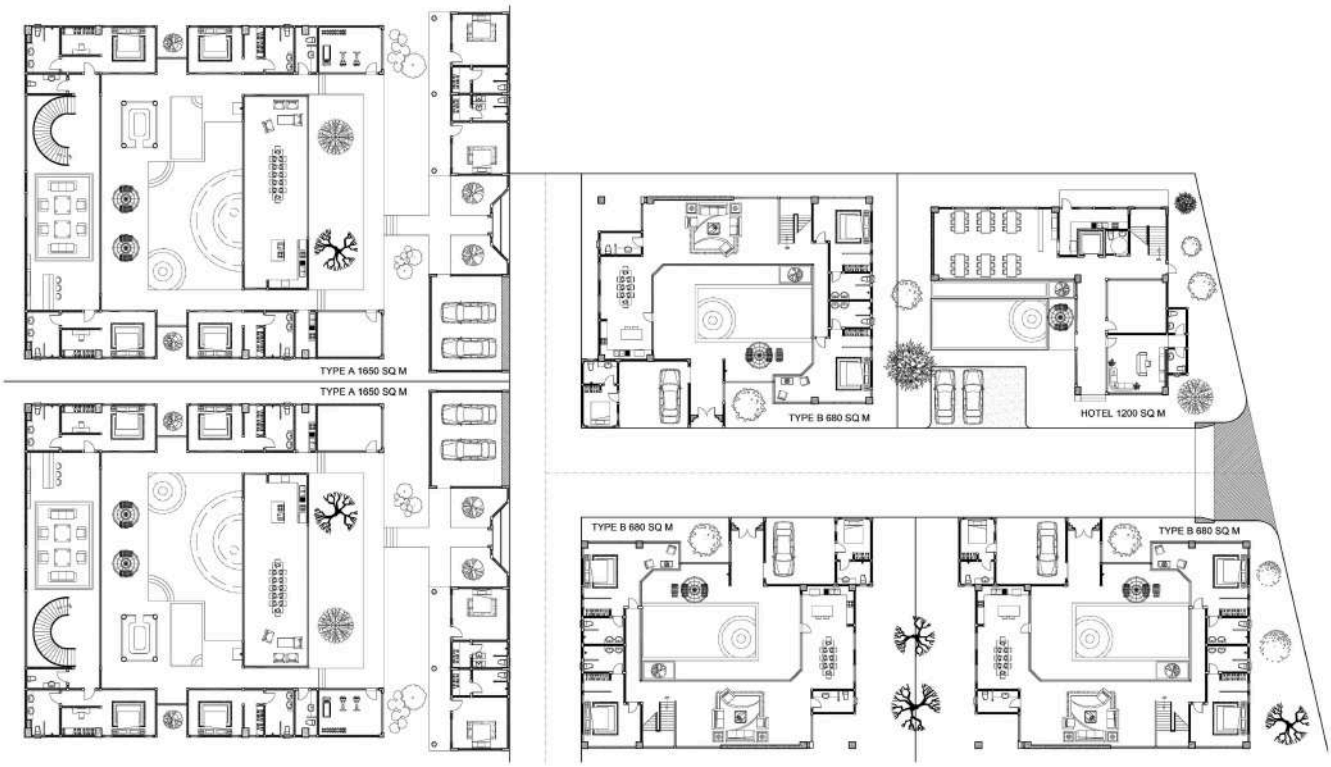
3. Architectural Strategy

The architectural design is based on long-span structural principles, reducing internal supports and enabling continuous interior spaces. The spatial organization follows open-plan configurations with direct connections between interior and exterior zones.

- Reduced column grid density
- Cantilevered elements extending beyond primary supports
- Indoor–outdoor spatial transitions
- Façade design optimized for solar shading and natural ventilation



Master plan showing spatial organization and volumetric arrangement.

The structural system of Sun Diego Resort Villa Pattaya is based on a hybrid configuration combining reinforced concrete, post-tensioned concrete, and steel cellular beams. The system was developed to achieve extended clear spans while reducing internal load-bearing elements and maintaining structural performance under tropical environmental conditions.

4.1 Span and Structural Efficiency

- Conventional reinforced concrete residential grid: typically 4–6 m column spacing
- Project implementation: clear spans ranging from 15 m to 30 m
- Outcome: reduction of internal columns by approximately 60–80% depending on zone

This reduction enables large open-plan configurations and increases spatial flexibility compared to conventional residential construction.

4.2 Load-Bearing System

- Primary structure: post-tensioned concrete girders
- Secondary system: steel cellular beams for service integration
- Foundation: post-tensioned deep footing system adapted to local soil conditions

Cellular beams reduce structural depth while allowing integration of mechanical and electrical systems within the beam profile.

4.3 Material Performance

- Concrete compressive strength (tested): approx. 1000–1180 kgf/cm² (≈ 98–116 MPa)
- Recorded compressive load: approx. 1,139 kN at 14 days (cube test)
- Concrete supplier: CPAC (Thailand)

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ne 4999532 บ.วันดีกรุ๊ป เอเชีย จก.

CPAC PATTAYA LABORATORY
TEST CERTIFICATE

Specimen Mark	Sample Dimension (mm)	Product Code	Slump (cm)	Casted Date	Tested Date	Age (days)	Weight (kg)	Ultimate Strength		
								Load (kN)	Cube Stress (kgf/cm²)	Cube** Stress (kgf/cm²)
A 5	100 x 100 x 100	65H4A9AB32	70.00	27/11/2022	11/12/2022	14	2.42	1139	1160	1114
A 6	100 x 100 x 100	65H4A9AB32	70.00	27/11/2022	11/12/2022	14	2.45	1048	1068	1025

Concrete delivery documentation showing high-strength mix specification (approx. 1000 kgf/cm² class) used for structural elements. The documented mix corresponds to controlled test values referenced in this section. Image credit: © Mario Kleff.

Material selection was optimized for durability under high humidity, thermal variation, and exposure conditions typical of tropical climates.

4.4 Compliance and Standards

The structural design and execution were carried out in accordance with:

- Thai Building Control Act B.E. 2522
- Engineering Institute of Thailand (EIT) structural design guidelines
- Relevant international references including ACI 318 (Concrete Design) and PTI recommendations for post-tensioning systems

4.5 Observed Performance

- Significant reduction in internal structural obstructions
- Improved spatial continuity and architectural flexibility
- Increased coordination requirements between structural and architectural systems
- Higher construction complexity compared to conventional reinforced concrete systems

Structural calculations, post-tensioning records, and material test reports are documented as part of the project archive and were reviewed by a licensed engineering consultant in Thailand.

4.6 Comparative Structural Analysis

The following table compares the implemented hybrid long-span system with conventional reinforced concrete residential construction methods commonly used in Thailand.

Typical Span	4–6 m	15–30 m	Up to ~5× increase in span capability
Column Density	High (dense grid)	Reduced (selective placement)	Approx. 60–80% reduction in internal columns
Structural Depth	Moderate	Reduced via cellular beams	Improved integration of building services
Spatial Flexibility	Limited by column grid	High (open-plan layouts)	Greater adaptability of interior space
Material Strength	Typical 240–400 kgf/cm²	Approx. 1000–1180 kgf/cm²	Higher load capacity and durability
Construction Complexity	Low to moderate	High (post-tensioning, coordination)	Requires specialized expertise
Construction Cost	Lower initial cost	Higher initial cost	Offset by spatial and architectural value
Execution Sensitivity	Moderate	High (tendon stressing, sequencing)	Greater need for quality control
Service Integration	Separate routing required	Integrated within beam structure	Reduced ceiling congestion
Suitability (Tropical Climate)	Standard performance	Optimized through material selection	Improved durability and ventilation potential

Values for the hybrid system are based on project-specific data and construction records. Conventional system values represent typical residential construction practices in Thailand.

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5. Development Timeline

Phase	Year	Description
Concept and Planning	2022	Initial project planning under the name Lieb Tang Rodfai Villas
Construction Phase	2023–2024	Execution of primary structural and architectural works
Public Opening	2024	Initial operational phase
Completion	2025	Completion of construction and development works

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Construction was carried out by Wandeegroup Asia Co., Ltd., in accordance with the project's architectural and structural design framework.

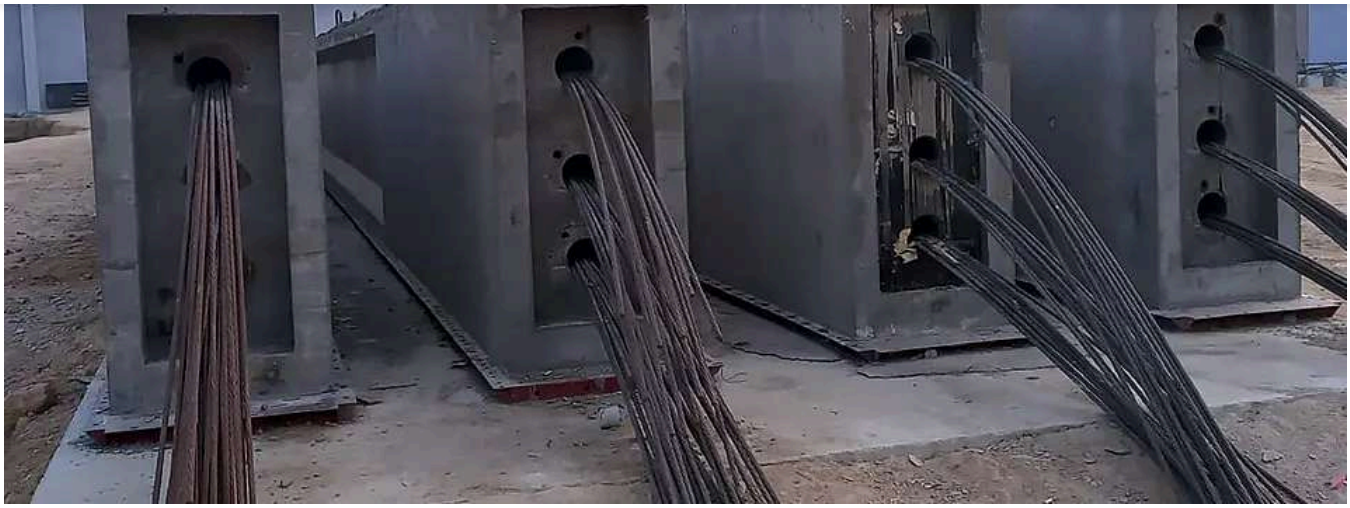
Post-tensioning works were executed by Span Systems International Co., Ltd., a contractor responsible for post-tensioned structural systems, implementing tendon systems and stressing operations within the project.

Scope of post-tensioning works included supply and installation of tendon systems, stressing operations, anchorage systems, and on-site technical supervision.

Fabrication and welding of custom cellular steel beams were carried out by B.S.Y. Construction Co., Ltd., including cutting, profiling, assembly, and structural welding of beam elements.

Scope included fabrication of perforated (cellular) beam sections, welding of web openings, and preparation of connection interfaces for on-site installation.

Installation of long-span prestressed concrete girders (up to 30 m) forming the primary structural framework.



Post-tensioned concrete beams with clearly visible tendons following casting, prior to stressing and finishing. Showing integration of the long-span structural system.

Post-tensioned concrete footing with visible tendons after casting, before stressing and finishing. Part of the integrated long-span structural system.

7. Cultural & Ceremonial Context

Traditional Thai blessing ceremony conducted on July 8, 2022, marking formal initiation of development activities.

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8. Project Stakeholders

The project included participation from private international investors.

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9. Design Methodology

Architectural form, structural systems, and construction processes were developed as an integrated design and delivery framework.

- Structural systems used as a primary design parameter
- Minimization of redundant structural elements
- Alignment of engineering logic with spatial organization
- Alignment between design development and construction execution

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10. Citations & References

Design and engineering principles referenced from standard reinforced concrete and post-tensioning methodologies, aligned with Thai engineering practice.

Project-Specific & Media Sources

1. The Thaiger – *Raising King and Queen Pillars Ceremony near Lieb Tang Rodfai Road*. News article.
2. CAANdesign – *Lieb Tang Rodfai Villas: Architectural Excellence in Pattaya*. Project feature.
3. Archello – *Sun Diego Resort Villa (Lieb Tang Rodfai Villas) – Project Coverage*. Project publication.

4. Sun Diego Resort Villa (Official) – *Architectural Overview*. Official project documentation.
5. Project Documentation by Mario Kleff – *Sun Diego Resort Villa Pattaya (Lieb Tang Rodfai Villas), 2022–2025*.

Engineering Standards & Academic References

6. Academic Journal of Architecture and Geotechnical Engineering – *Design and Construction Techniques of Prestressed Concrete Structures in Bridge Engineering*.
7. Federal Highway Administration (FHWA) – *Comprehensive Design Example for Prestressed Concrete (PSC) Girder Superstructure*.
8. Kotsovos, M. D, Pavlovic, M. – *Ultimate Limit-State Design Of Concrete Structures: A New Approach*
9. Oasys GSA – *Model Code for Concrete Structures*.
10. Journal of Science and Technology in Civil Engineering (JSTCE) – *Simplified Design Method and Parametric Study of Composite Cellular Beams*.
11. MDPI – *Durability Requirements for Reinforced Concrete Structures in Tropical Coastal Environments*.
12. ScienceDirect – *Corrosion Failure Analysis of Structural Steels in Tropical Marine Atmospheres*.

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11. Related Work

Other projects by Mario Kleff include Majestic Residence Signature Villa in Pattaya, Thailand.

12. External Links

Official architect website: https://mario-kleff.com

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13. Glossary & Technical Terms

- Long-span structure: Architectural and engineering system minimizing internal supports for open interior spaces.
- Cantilever: Structural element projecting horizontally beyond its support.
- Structural integration: Harmonization of architectural form and load-bearing systems.

14. Limitations & Constraints

While the long-span structural system provides significant spatial and architectural advantages, several limitations were identified during design and construction:

- **Construction Complexity:** Post-tensioning systems require specialized expertise, equipment, and sequencing.
- **Cost Implications:** Initial construction costs are higher compared to conventional reinforced concrete systems due to materials and technical requirements.
- **Coordination Requirements:** Increased integration between architectural, structural, and mechanical systems is necessary.
- **Execution Sensitivity:** Errors in tendon placement, stressing, or anchorage can significantly affect structural performance.
- **Limited Contractor Availability:** Specialized contractors are required for post-tensioning and cellular beam fabrication.

These constraints should be considered when applying similar structural strategies in comparable residential developments.

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15. Data Availability

Selected structural calculations, material test records, and construction documentation are available upon request for verification and academic reference purposes.