miyamoto.

Performance Based Engineering

Maximise Safety, Minimise Costs

About

We are a global engineering and humanitarian firm, providing expert solutions to sustain industries and safeguard humanity.

Our Structural + MEP engineering team turns our clients' design, economic, sustainability, and resiliency challenges into opportunities. We provide high-performance-based engineering expertise to reduce construction materials and enhance resiliency, sustainability, and investment. Our clients get the best of local and global engineering talent in the education, healthcare, civic, distribution, life science, residential, and commercial sectors. We are experts in earthquake-resilient engineering that reduces damage and facilitates disaster recovery.

Our International Development + Humanitarian Assistance team provides expertise in climate, disaster, and urban resilience. We are experts in delivering post-conflict and disaster recovery strategies. Our data-driven expertise comes from responding to more than 100 global disasters. We have assessed more than 600,000 damaged buildings and reconstructed more than 50,000 structures. Our multidisciplinary expertise supports how communities address the economic, political, socio-cultural, sustainability and technical challenges in the world's most challenging environments.

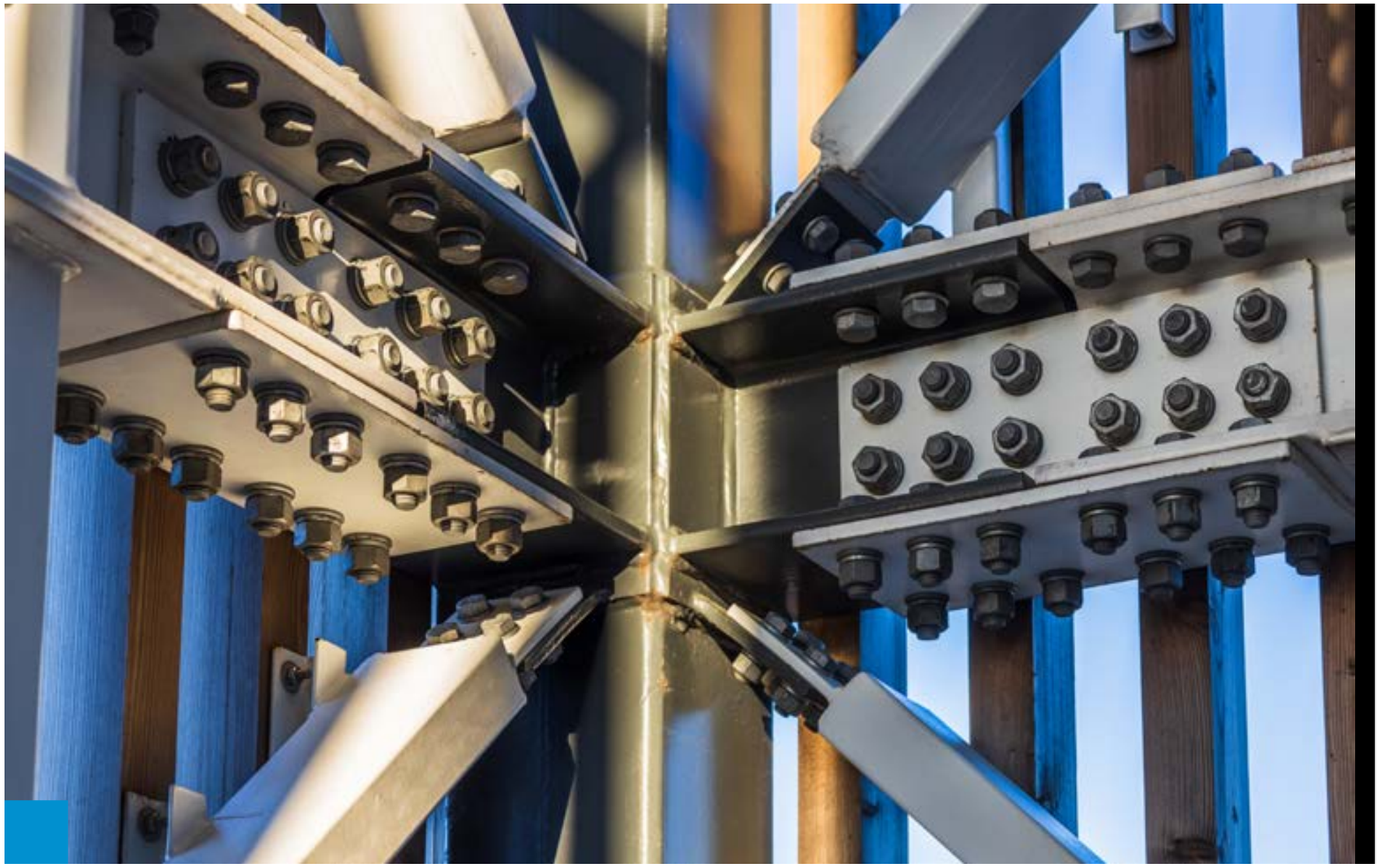
We are strategically located in 30 worldwide locations to save lives and impact economies. We make the world, a better, safer place.

We make the world a better, safer place.

Maximise Safety, Minimise Costs.

In the ever-evolving landscape of structural engineering, Performance-Based Engineering (PBE) has emerged as a transformative approach that redefines how we design and retrofit buildings for seismic resilience. PBE is a sophisticated methodology that goes beyond the limitations of prescriptive building codes, empowering engineers to create tailored solutions that optimise structural performance while minimising costs and mitigating risks.

Save lives, impact economies.



Performance-Based Engineering (PBE marks a paradigm shift i n structural design, focusing o n achieving specific performance outcomes, p articularly in seismic resilience. Unlike traditional methods that follow rigid criteria, PBE tailors solutions to meet exact needs—enhancing safety, reducing costs, and mitigating risks. At Miyamoto New Zealand, we leverage PBE to design structures that not only meet but often exceed global safe-ty standards. By integrating advanced analytical tools and innovative methodologies, such as nonlinear analysis and probabilistic risk assessments, we optimise the performance of buildings under any loading conditions. Our commitment to innovation is highlighted through our pioneering work in regions prone to seismic activity, where our tailored solutions have consistently proven their value in real-world applications. We focus on not just meeting, but exceeding, the unique needs of each project, ensuring rapid recovery and functionality post-event, and substantial cost savings through efficient design strategies.

PBE Advantages

Cost-effective solutions: Our advanced performance-based design techniques and testing capabilities allow us to develop optimised retrofit designs that minimise unnecessary costs while ensuring the required seismic performance.

Reduced project timelines: Access to quick testing labs and efficient numerical modeling tools enables us to deliver retrofit designs faster, reducing overall project duration and minimising downtime for building occupants.

Proven track record: Our successful application of these advanced techniques in challenging projects demonstrates our expertise and ability to deliver innovative, reliable, and cost-effective solutions.

Comprehensive services: By combining advanced numerical modeling, physical testing, and conventional design approaches, we provide a complete suite of structural engineering services tailored to the unique needs of each project.

Transforming Engineering with Cost-Effective, Customised Solutions.

Miyamoto Direct SSI Analysis

Innovative Solutions: Our cutting-edge Python code bridges the gap between ETABS and Abaqus, providing a unique solution that enhances efficiency and accuracy.

Our Direct Soil-Structure Interaction (SSI) analysis offers a holistic approach to modelling the complex interactions between structures and the supporting soil. This method ensures a more accurate and reliable assessment of structural behaviour under various loading conditions, leading to safer and more cost-effective designs.

Key Advantages:

1. Enhanced Accuracy:

- By simulating both soil and structure within Abaqus, our analysis captures the true response of the system, accounting for the dynamic interactions between the soil and the structure. This leads to more precise predictions and more cost-effective solutions for structural design for new and existing buildings.

2. Integrated Workflow:

- We streamline the process by converting structural models from ETABS to Abaqus using our proprietary Python code. This seamless integration reduces potential errors and saves significant time, ensuring a smooth transition between software platforms.

3. Advanced Modelling Capabilities:

- Abaqus provides advanced finite element analysis capabilities, allowing for the modelling of complex soil behaviours and non-linear interactions. This enables a more detailed and realistic representation of the SSI phenomena.

4. Improved Design Insights:

- Our SSI analysis helps identify critical design factors that might be overlooked in conventional methods. This leads to optimised designs that are better suited to withstand environmental and operational loads. This provides the dual benefit of reduced costs and better performance for your structure and buildings.

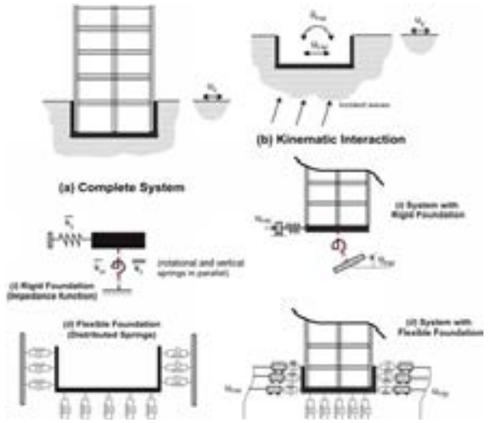
While this method simplifies the analysis, the limitation of modelling the springs beneath the foundation as independent from each other does not fully capture the actual behaviour of the soil. Additionally, estimating spring stiffness is unreliable without any real solution proven globally.

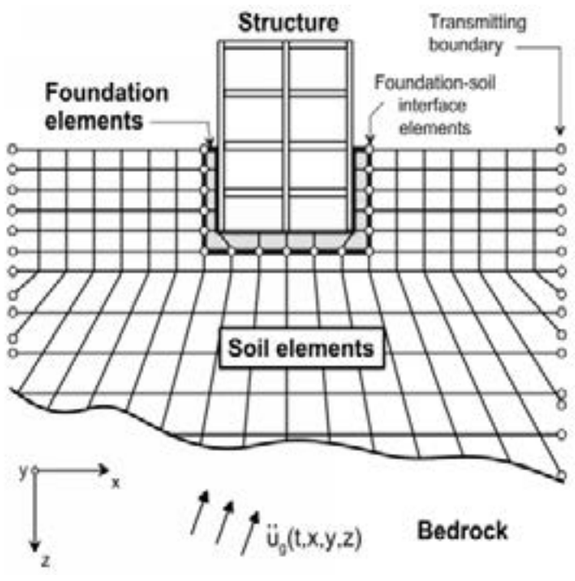
Key Difference of Conventional vs Miyamoto Direct Analysis

Conventional/Substructure Approach

Substructure Approach: the total system is divided into two main components: the superstructure (above ground) and the substructure (foundation and soil).

While this method simplifies the analysis, the limitation of modelling the springs beneath the foundation as independent from each other does not fully capture the actual behaviour of the soil. Additionally, estimating spring stiffness is unreliable





Miyamoto Direct SSI Analysis Approach

Direct SSI Analysis - the soil is often represented as a continuum (e.g., finite elements) including the foundation and structural elements, this allows for transmitting boundaries at the limits of the soil mesh, in addition to interface elements at the edges of the foundation.

The modelling of the soil as a continuum beneath the foundation with incorporation of a non-linear (separable) contact between the foundation and soil, a more realistic interaction between the soil and structure. In addition, allowances for limited foundation rocking and better energy dissipation, are utilised resulting in more accurate and cost-effective solutions.

By accurately modelling the behaviour of the soil-structure system, engineers can optimise the design and use materials and resources more efficiently that reduce construction and maintenance costs without compromising safety

Direct SSI Analysis adds benefits to various types of structures from buildings to civil infrastructure and is applicable to new design and structural/seismic improvements to existing structures.

NASA-Grade Analysis.

State-of-the-art testing facilities and advanced analytical capabilities ensure precise, reliable solutions.

Pioneering Solutions.

Unlocking hidden structural potential to optimise performance and minimise costs.

CASE STUDY

Wellington Tower Revival: The Terrace

Challenge: 23-storey building with unique structural system requiring seismic upgrade.

Solution: Targeted strengthening based on full-scale testing and advanced FEA.

Result: Retrofit cost reduced from $20 million to $5 million while meeting performance objectives.

Built in 1964-65, 105 The Terrace is a 23-storey, 68-metre tall building in central Wellington. This structure features a unique composite design with concrete-encased steel lattice columns, a 7-story podium, 16-story tower, and 3-story penthouse.

Initial seismic assessments suggested a need for extensive retrofitting, including mid-height base isolation. This conservative approach was estimated to cost approximately 20 million NZD and posed significant challenges for building functionality and occupant disruption. Based on the PBE findings, Miyamoto developed a targeted retrofit strategy involving steel jacketing of columns between levels 6 and 8 and installation of 4 viscous dampers on each side of the building at critical levels. This approach resulted in a dramatic reduction in retrofit costs from 20 million to 5 million USD, representing a 75% savings.

The Terrace

CASE STUDY

13-27 Manners Street

13-27 Manners Street is a modern 15-storey commercial tower building in the heart of downtown Wellington. The reinforced concrete tower building was built in the 1980s, and its primary weaknesses were the precast floor units which lacked strength and were vulnerable to building deformation.

Miyamoto provided seismic rehabilitation services to address the building deficiencies. Traditional strengthening solutions would require invasive work to the interior. Miyamoto's approach was to incorporate fluid viscous dampers into the existing concrete frame. By adding energy dissipation, building drift and acceleration reduced.

In addition to the structural benefits, working only around the perimeter and isolated internal locations minimises downtime, disruption and refurbishment costs during construction.

In the design, Miyamoto employed sophisticated structural analysis and laboratory testing, and were actively engaged with the contractor to develop a resilient retrofit solution with a performance objective above Life Safety.

By adopting a higher performance criterion, the client can minimise time for re-occupancy and functional recovery, as well as direct financial losses following a seismic event.

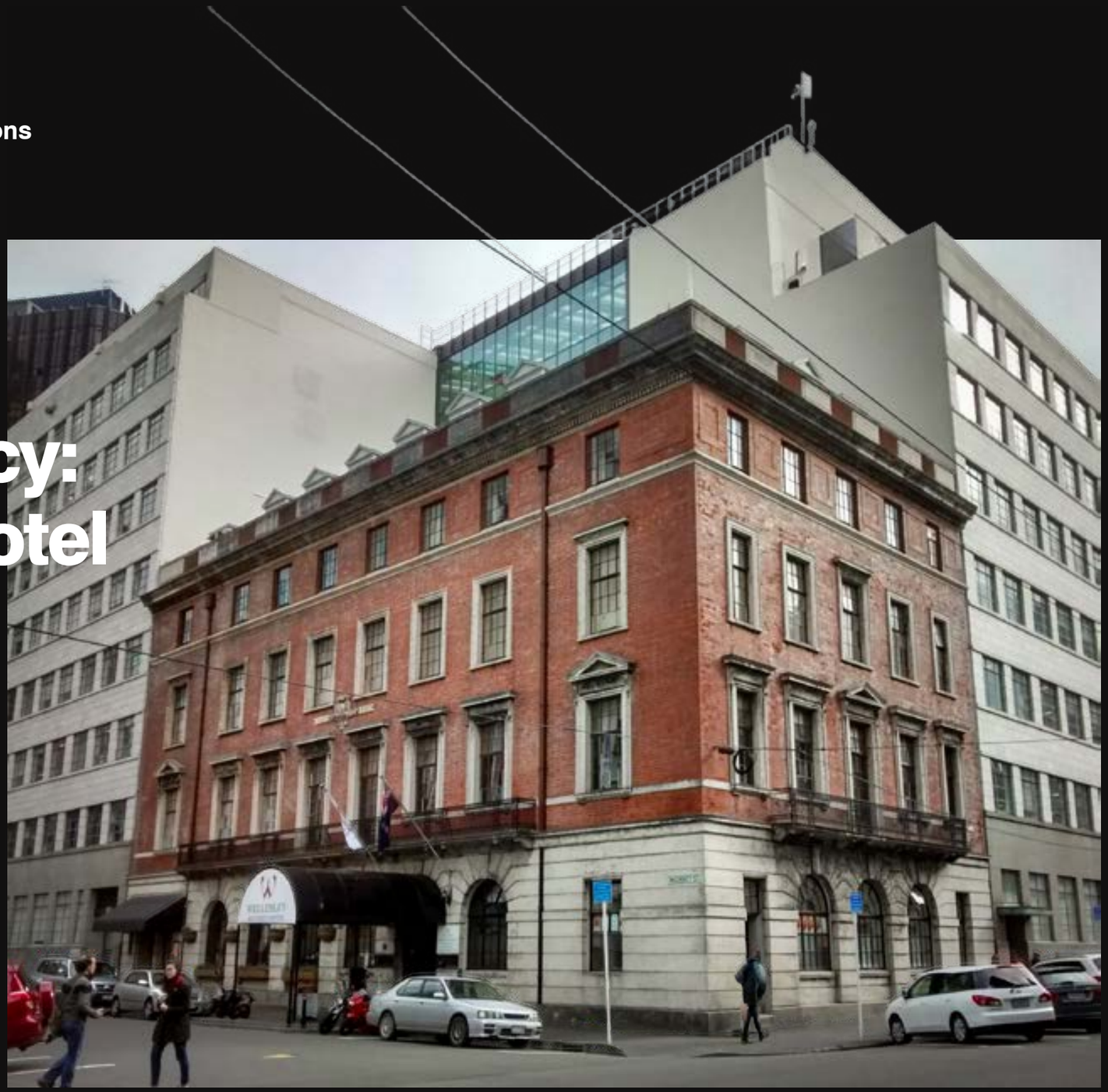
Cost-Effective Customised **Solutions**

CASE STUDY

Reviving a Legacy: The Wellesley Hotel

The Wellesley Boutique Hotel project exemplifies the application of performance-based engineering in the seismic rehabilitation of heritage structures. This Category 1 heritage building, constructed on reclaimed land along Wellington's waterfront, presents unique challenges due to its concrete frame with unreinforced masonry infill and facade, as well as its location on potentially liquefiable soil. Miyamoto's comprehensive approach encompasses seismic assessment, 3D scanning, geotechnical evaluation, and innovative strengthening techniques to achieve 60% New Building Standard while preserving the hotel's Georgian revival style and classical detailing.

The rehabilitation strategy features an innovative strengthening scheme using central coring and post-tensioning for unreinforced masonry, minimising alterations to architectural elements. Simultaneously, Miyamoto explores advanced ground remediation techniques like resin injection to mitigate liquefaction risks. This holistic approach addresses seismic vulnerabilities while preserving historical significance, demonstrating the potential of advanced engineering in safeguarding cultural heritage.



The Wellesley

Future-Proofing Structures.

Engineering resilience for
tomorrow’s challenges, today.

Our experts collaborate across Miyamoto's global network.

Our PBE experts collaborate across Miyamoto's global network, bringing together diverse experiences and insights. With multidisciplinary teams adept at tailoring PBE solutions to unique project requirements, we offer comprehensive expertise that adapts to the specific needs of each structural challenge we encounter.

Amir Moshref
Technical Director (Structural)

David Weir
Managing Director

Nick Regos
Managing Director

Dr. Kit Miyamoto
Global CEO & Structural Engineer

Our Experts

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Ready to optimise your next project?

Our New Zealand team‘s groundbreaking work in PBE is now available to clients across the United States. By combining our global knowledge base with local expertise, we deliver unparalleled structural engineering solutions tailored to your specific needs and local conditions.

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Maximise Safety, Minimise Costs.

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