

Earthquake Engineering





Earthquake Engineering

For over half a century, Beca have pioneered earthquake engineering. From the world's first capacity designed building, to the first base isolated bridge, we've been at the forefront of protecting lives and assets from earthquakes.

Our home in the shaky isles of Aotearoa New Zealand means designing for earthquakes is at the heart of all our work. It's in our DNA. We have seismic solutions for a wide range of projects. Whether you need cutting-edge dynamic optimisation on a major project, the latest in go-anywhere earthquake alerting, pragmatic retrofits for heritage buildings, or a major asset portfolio assessment, our team of seismic specialists can help you out.

Who we are

Beca is one of Asia Pacific's largest independent advisory, design and engineering consultancies. After a century of operation, we have grown from a family-owned business to one of the most progressive, client-centric professional services consultancies in our region. We have more than 3,800 employees in 24 offices around the world and have delivered projects in more than 70 countries.

We have over 300 structural engineers, delivering seismic design, assessment and advice as a core part of their projects.

Our employee-ownership model remains key to our future. It underpins our commitment to building and sustaining long-term relationships with our clients, it helps drive our positive, purpose-driven, and growth-oriented culture, it sets us apart from our competitors, and it gives meaning to our social contract.

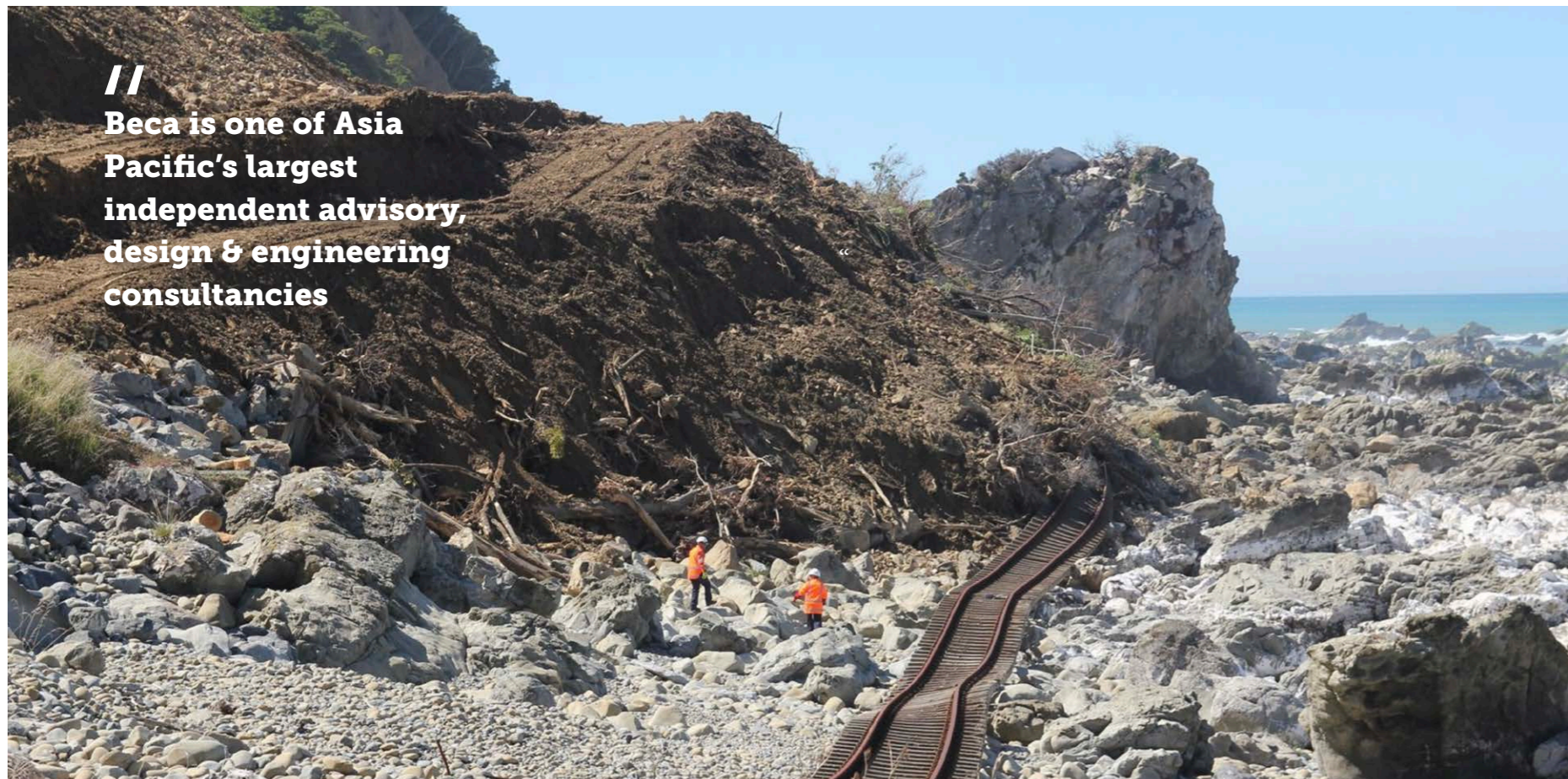
While our experience has been 100 years in the making, it is the fresh talent we're nurturing, the innovative thinking we're developing and the connections that we're forging that get us most excited for the future.

What we do

Whether you need to understand the seismic performance of a single building, or manage your earthquake risk across an international asset portfolio, Beca can help you find the right solution.

We offer a full range of earthquake engineering services, including:

- Seismic Assessment and Strengthening
- Seismic Risk Advice
- Multi-Objective Optimized Dynamic Design (MOODD)
- Sustainable Re-use in Seismic Regions
- Specialist Seismic Design
- Seismic Protection of non-structural elements
- Post-Earthquake Support
- Codes, Standards and Guideline Advice
- Natural Hazard Risk and Resilience Advice
- Tuned Fluid Viscous Dampers
- Seismic Isolation
- Site Specific Hazard Assessment
- Seismic Geo-hazards
- Beacon automated post-earthquake alerting system
- Non-linear time history analysis
- Earthquake Insurance Support



// Beca is one of Asia Pacific's largest independent advisory, design & engineering consultancies

Pioneers of Earthquake Engineering



1968

Jerningham Apartments

Beca engineer the world's first capacity designed building, a method now central to seismic engineering worldwide



1974

Beca designed the Rangitikei Railway

The world's first base isolated bridge – built in one of New Zealand's most challenging environments



2001

7.7Mw Gujarat Earthquake, India

Beca managed the design for NZAID of the base isolation of a 400-bed hospital to replace the Bhuj hospital devastated in the earthquake – the first base-isolated building in India



2010-2011

7Mw / 6.3Mw Christchurch Earthquake sequence

Beca assessed more than 2,000 structures for earthquake damage, designed repairs and strengthening for damaged buildings and designed new buildings to replace others that had to be demolished

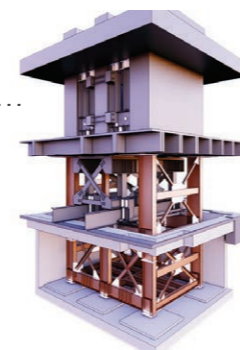


2016



Beca develops Beacon

A real time alerting system designed to assist building owners with understanding the impact of earthquakes on their assets



2016-2022

Earthquake response,

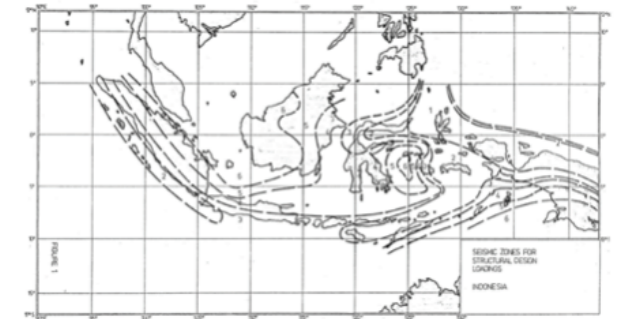
Support, seismic assessment and remedials following major seismic events in Jakarta, Melbourne & Wellington

1970-1993

Beca develop seismic codes

And guidelines for Indonesia, the Philippines, Papua New Guinea, and Nepal

1973 - Philippines
1981 - Indonesia
1982 - PNG



1993

Nepal Codes

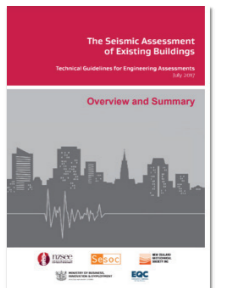
Beca prepared the seismic loadings and building code for Nepal



2007-2017

Beca lead the preparation of national seismic assessment guidelines

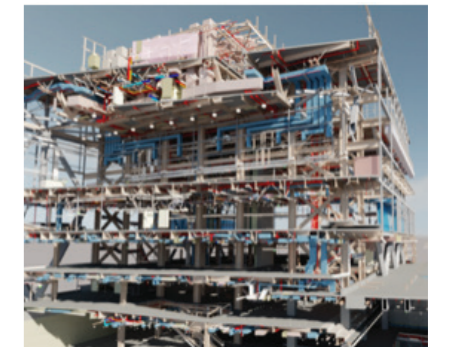
For existing buildings which is now required to be used to assess all buildings in New Zealand



2012

Improvement of non-structural element seismic resilience

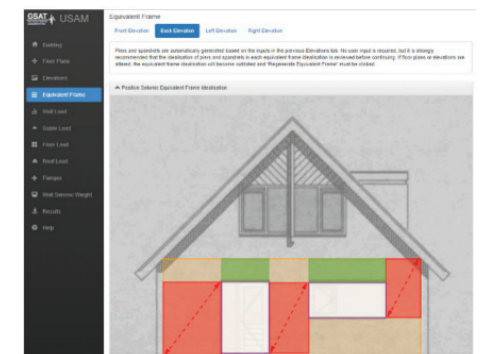
In new and existing buildings through Beca's programme of innovative design and construction solutions



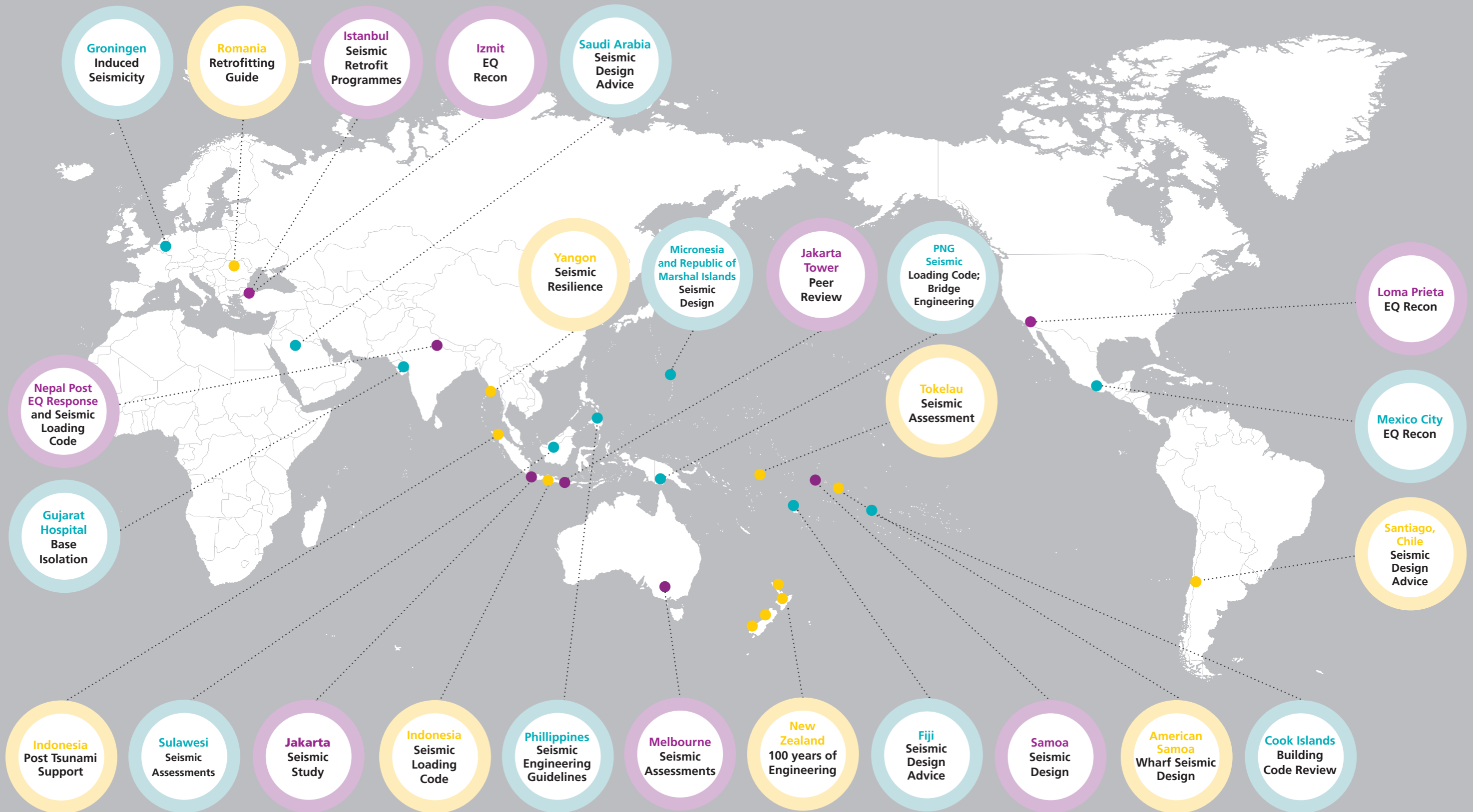
2016

Groningen seismic assessments:

Beca developed an innovative web – based system to complete fast reliable consistent structural assessments of over 120,000 houses in the Netherlands



A snapshot of our Global Seismic engagements



Case Studies



Rankine Brown Library Seismic Retrofit

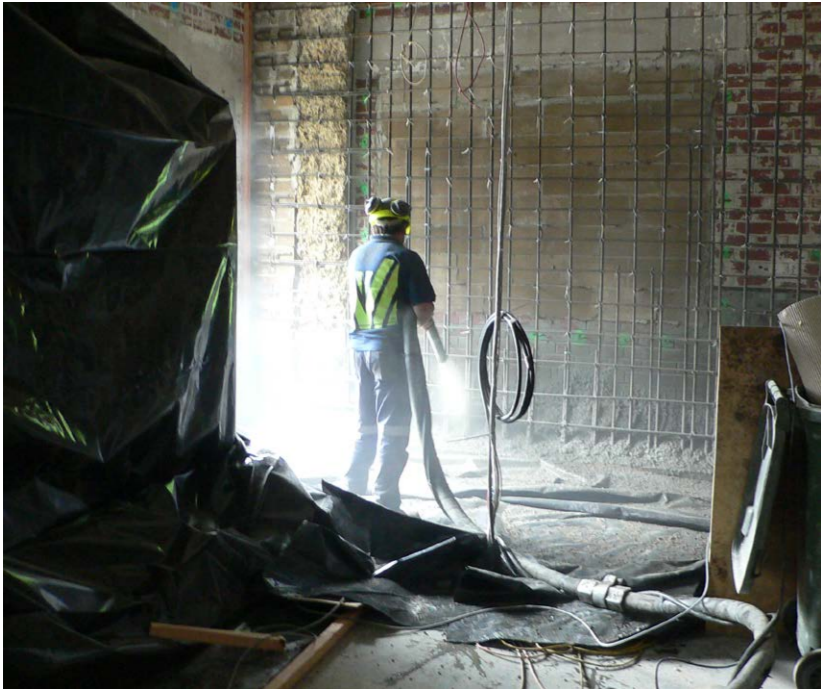
Beca’s structural team inspected the building hours after the 2016 Kaikōura earthquake, and our assessment found the two lift shafts had sustained significant damage, although the rest of the building was relatively unscathed.

We undertook a Detailed Seismic Assessment and installed temporary supports to secure the shafts, which allowed the library to reopen.

Our client then commissioned Beca to devise a base isolation scheme

for the lift shafts; this was an unusual challenge and potentially a world first. It required creative thinking to overcome the constraints of a short timeframe and incredibly tight site within the building – while keeping the library operational. There was also a significant carbon dividend, as restoring full use of the lifts was far more sustainable than demolishing and building a replacement library, which was a serious consideration.

The complexity of this five year project was recognised at the 2022 IStructE ‘Structural Awards’ - the world’s premier structural engineering awards.

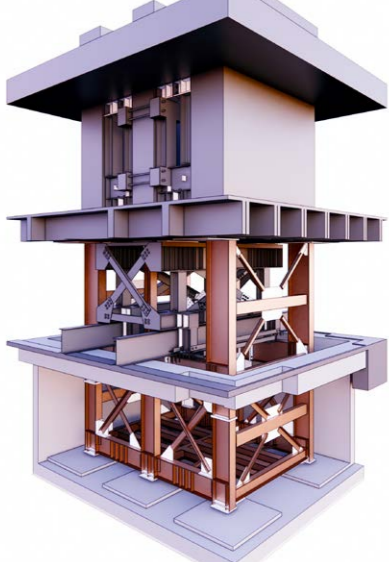


Seismic Assessment & Strengthening

Over the past decade, Beca has seismically assessed thousands of buildings. From modern hospitals in New Zealand to historic houses in the Netherlands. From high-rises towers in Jakarta, to Industrial facilities in the Pacific Islands.

We have a team of world-renowned experts, supported by hundreds of experienced structural seismic engineers. For Beca, seismic assessment isn’t an optional extra, it’s something we live and breathe, it’s in our DNA.

This breadth of knowledge allows us to help you with your buildings, no matter the situation. Whether you need a pragmatic fix for a rural school, a damage limiting design for a critical hospital, or an entire asset portfolio assessed, we have the expertise and the scale to help you out.



“Great pains have been taken to restore this library following earthquake damage and the efforts to justify the building through repairs and upgrade are admirable, providing enormous savings on the alternative of new construction. The design implemented improvements beyond code requirements under severe working constraints as the library remained in use throughout”

-IStructE Award Citation (2022)

Seismic Risk Advice

Seismic risk can be a complex area for decision-makers to navigate. Earthquakes are inherently unpredictable, and the stakes for important buildings can be very high.

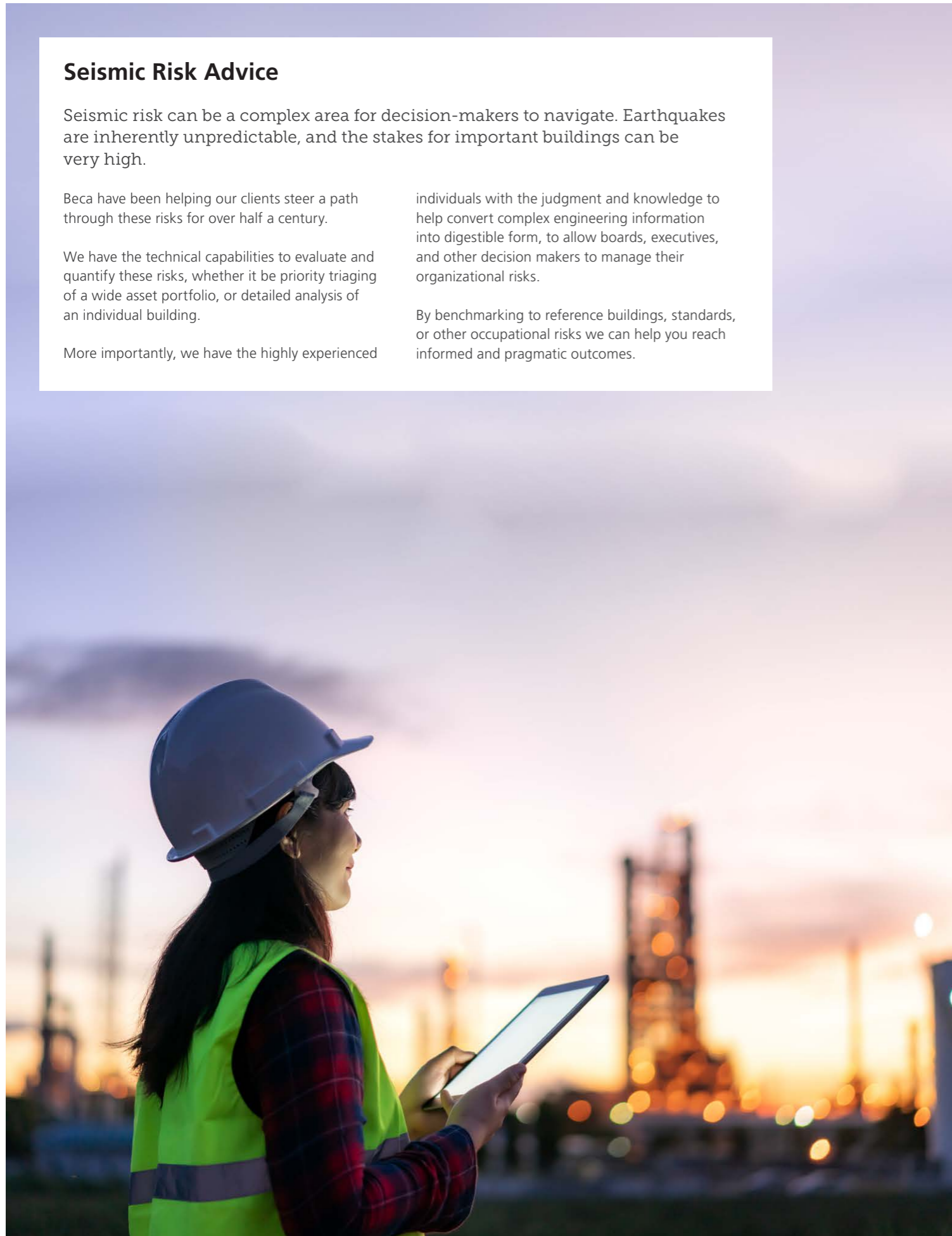
Beca have been helping our clients steer a path through these risks for over half a century.

We have the technical capabilities to evaluate and quantify these risks, whether it be priority triaging of a wide asset portfolio, or detailed analysis of an individual building.

More importantly, we have the highly experienced

individuals with the judgment and knowledge to help convert complex engineering information into digestible form, to allow boards, executives, and other decision makers to manage their organizational risks.

By benchmarking to reference buildings, standards, or other occupational risks we can help you reach informed and pragmatic outcomes.



Bay of Plenty District Health Board

Beca was brought on board to help the Bay of Plenty District Health Board (BOPDHB) with their Tauranga and Whakatane campus wide seismic assessment programme due to our proven track record and expertise.

The project began with a briefing of the BOPDHB's requirements and objectives. The key message taken from this was to understand

the risks the BOPDHB will be exposed to through a seismic event. Furthermore, how Beca could drive the delivery of low-cost effective solutions to help mitigate this risk in a structured and efficient manner.

We have worked closely with Property Services for nearly a decade to understand the functionality of each building and how critical these buildings are to the continued operation of the hospital. Continuity of operations is a paramount factor when determining the level of seismic risk. The assessment results are then coupled with the expected life of the building and future facility plans. This involved extensive coordination with Property Services and key staff to agree on appropriate risk reduction strategies.



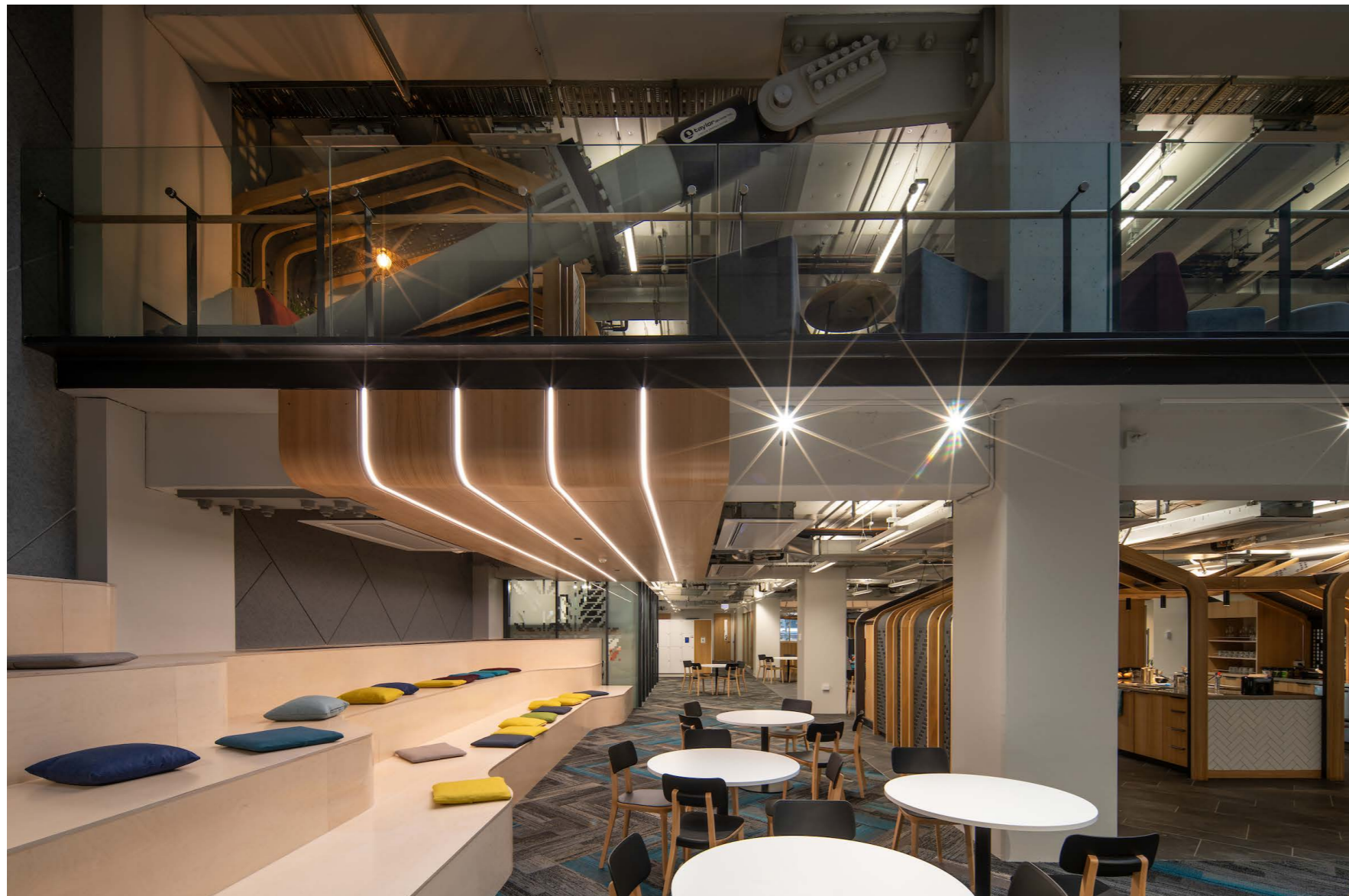
MOODD (Multi-Objective Optimized Dynamic Design)

Despite advances in computational power, it had remained impractical to optimise dynamic design due to the highly non-linear nature of dynamic analysis.

Beca have now developed a means to optimise dynamic design in a way never before possible, with strict performance criteria focusing on seismic resilience and limiting loss. When paired with the right projects – particularly those using damping devices, seismic retrofits, and projects with strict performance criteria, the potential benefits are significant.

Sample viscous damper retrofit projects show that building drifts and accelerations can be halved, whilst using less than half of the viscous dampers required through a traditional non-optimised design.

For the right project, the advantages in partnering with Beca and use of the MOODD process can be enormous.



8 Willis Street, Wellington, New Zealand

A world-leading seismic retrofit.

Beca's retrofit of 8 Willis Street turned a building that no longer met the market's requirements for seismic performance into one of Wellington's most resilient workspaces.

Our breakthrough in structural analysis enabled us to add five floors to the 1980s tower at 8 Willis Street. It already had eight storeys, but we extended the footprint and brought the structure up to market-leading seismic resilience – achieved with just 12 large fluid viscous dampers and a minimally invasive structural retrofit.

This cutting-edge approach involved modelling the location of dampers, shear walls and other structural components, and testing the design against dozens of historic earthquake records from around the world.

The building's commercial prospects were transformed. The retrofitted 1980s tower links to a new development at Stewart Dawson's Corner, which cantilevers over the historic 1900s building

– our work included strengthening the landmark facade and renovating original timber roof.

Our seismic upgrade has delivered the benefits of a new build, but in less time and at lower cost. Minimal work was required on the building's foundations, further simplifying the construction programme, and thousands of tonnes of concrete were retained in situ – a big sustainability dividend.

The result is a 12,300m² modern, open plan workspace rated at 130%NBS (IL2). The retrofitted 1980s building has a clean interior, free from the intrusive structural interventions that would normally be required to achieve such a high level of resilience. In fact, there are more floors without dampers than with them.

Our game-changing structural optimisation work is equally applicable for retrofit and new build projects – opening the door to buildings that are more resilient, less complex to construct and with a reduced carbon footprint.



Sustainable Re-Use in Seismic Regions

This embodied carbon reduction strategy prioritizes “Build Nothing” (refurbishment) as the most impactful means of reducing embodied carbon.

This can present some complexities in non-seismic regions, but in seismic regions, it represents some of the most difficult engineering that structural engineers must face. We are required to forensically unpack the dynamic behavior of historic buildings,

often with scarce available information, and then retrofit those buildings to make them safe for modern use.

Striking the right balance between safety, carbon reduction, and cost requires a wide toolkit of solutions. Sometimes complex damper or isolator solutions are needed, or it might simply be selective modification of a few critical elements to introduce ductility to a building. Our unrivaled experience in this area means we can offer a full spectrum of solutions.



University of Auckland Social Sciences Building

The University’s Social Sciences Building has been awarded a 6 Green Star rating. It has been given 93 points, the highest score to date issued by the New Zealand Green Building Council.

Beca’s seismic retrofit enabled a 50-year life extension and complete refurbishment of the existing structural frame.

This adaptive re-use of decades old building resulted in 60% less emissions for construction and operation over its lifetime compared to an equivalent new building. The building will send less waste to landfill and create less pollution.

The pivotal insight from Beca’s seismic assessment was to replace the heavy and deteriorating concrete facade with an energy efficient and lightweight alternative. This weight reduction enabled an additional story and circulation core to be provided which enhanced the amenity and overall viability of the project without increasing seismic risk.

Beca Experts

We have rich pool of structural engineering seismic specialist leaders. Our people are spread across New Zealand, Australia, Thailand, Singapore and Indonesia.



Richard Sharpe
Senior Technical Director
Seismic Codes / Policy
Wellington, NZ



Kam Weng Yuen
Technical Director
Structural / Seismic Engineering – S.E Asia
Singapore



Jared Keen
Technical Director
Global Seismic Projects
Christchurch, NZ



Juliane Spaak
Technical Director
Global Seismic Projects
Wellington, NZ



Courtney Chapman
Associate
Global Seismic Projects
Wellington, NZ



Henry Tatham
Technical Director
Commercial Buildings
Wellington, NZ



Rob Jury
Chief Structural Engineer
Seismic Codes/Policy
Wellington, NZ



Neil Horsfield
General Manager
Earthquake Impact Alerting
Auckland, NZ



Dion Marriot
Technical Director
Seismic Engineering
USA



Arun Mankavu Puthanpuravil
Technical Director
Seismic Analysis / MOODD
Wellington, NZ



Andrew Baird
Associate
Non-Structural Seismic Restraint
Auckland, NZ



David Whittaker
Senior Technical Director
Damaged Buildings / Insurance Claims
Christchurch, NZ



Djuana Lesmana
Technical Director
Seismic Analysis
Jakarta, Indonesia



Milsa Djajasaputra
Associate Director - Structural
Commercial Buildings
Jakarta, Indonesia



Aaron Beer
Senior Technical Director
Heritage Building Strengthening
Wellington, NZ



Nicholas Charman
Technical Director
Seismic Assessment / Insurance Claims
Brisbane, AU



Jenni Tipler
Associate
Existing Buildings
Jakarta, Indonesia



Craig Lavin
Technical Director
Commercial Buildings NZ/ Pacific
Tauranga, NZ

South Rangitikei Viaduct
The world's first base
isolated bridge – built in
one of New Zealand's most
challenging environments



 **BECA**

**make
everyday
better.**