Te Hiranga Rū | QuakeCoRE

Aotearoa New Zealand Centre for Earthquake Resilience

2022 Annual Report

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Directors' Report 2022

Te Hiranga Rū QuakeCoRE formed in 2016 with a vision of transforming the earthquake resilience of communities throughout Aotearoa New Zealand, and after seven years of Tertiary Education Commission funding, we are seeing important progress toward this vision through our focus on research excellence, deep national and international collaborations, and human capability development.

In our sixth Annual Report we highlight several world-class research stories, collaborations with national and international partners, and education of the next-generation of researchers.

Te Hiranga Rū QuakeCoRE researchers continue to excel in disciplinary research that is both scientifically excellent as well as impactful. Furthermore, as we continue to consolidate our research community, we are increasingly seeing impactful multidisciplinary research emerge that is seeing traditional research questions solved in innovative ways. An example of this is the profiled story in this report on the use of CTV footage of the 2010-2011 Canterbury and 2016 Kaikōura earthquake sequences combined with detailed injury datasets. Such research involved health, engineering and social science researchers and practitioners, and leads to the ability to provide public messaging that has a strong scientific basis. Similarly, we also highlight an example of law experts in Te Hiranga Rū QuakeCoRE identifying legal issues with the Earthquake Prone Buildings Act, which was largely developed within an engineering mindset. This annual report also highlights innovations in structural earthquake engineering applied to the development of new connections comprised of multiple structural materials, and also innovation in the way we develop or restore Māori buildings. Finally, we also highlight the central role that Te Hiranga Rū QuakeCoRE plays in the national science and research ecosystem through annual science-based engagement activities, such as evaluating the national ShakeOut drill, as well as the delivery of major science products, such as the National Seismic Hazard Model.

As a Tertiary Education Commission Centre of Research Excellence, Te Hiranga Rū QuakeCoRE has a strong emphasis on human capability and capacity development, and harnessing such development through the communities we interact with, and the places and fora that members of the Te Hiranga Rū QuakeCoRE community participate in in their professional and personal lives. This Annual Report highlights several examples of outstanding university research students who have benefited from Te Hiranga Rū QuakeCoRE collaboration and enagagement to produce high-impact research.

As we continue to progress our research programme and activities for the 2021-2028 funding period, we are excited to address transformative research questions in partnership with mana whenua, industry, national and international research partners. We will continue to develop the next generation of leadership capability toward our collective vision of earthquake resilience.

Brendon Bradley
Director

David Johnston
Deputy Director

Caroline Orchiston
Associate Director

Anthony Hoete
Associate Director

Chair's Report 2022

I recently attended a festival held at Te Pae Christchurch Convention Centre. During my multi-day stay I also spent a couple of hours wandering around and admiring the new buildings and infrastructure that now provide a platform for a bustling, busy place that – in my view – is more vibrant and attractive that it ever was before the tragic events of 22nd February 2011.

I think Christchurch is built back better. I can see how Te Pae and other anchor projects have contributed to massive progress in developing Aotearoa New Zealand's resilience thinking over the last 12 years. This progress is reflected in this Te Hiranga Rū QuakeCoRE Annual Report, which provides a snapshot of research achievements, and I think that everyone associated with Te Hiranga Rū QuakeCoRE should be immensely proud of how far we have come.

Earthquake engineering continues to underpin the research programme, but it is exciting to see the emerging collaboration with partners to challenge strategic and interdisciplinary issues.

I am especially keen to see our body of work formalised and built into processes, policies and budgets around Aotearoa New Zealand. Because as humans we do tend to forget. As I write this Dr Jo Horrocks from EQC is quoted in the media, in the wake of Cyclone Gabrielle, stating:

> *A change is needed. We need to avoid or limit building on some of our highest-risk, or multi-risk, land. And we need to build smartly, to appropriate standards, where we do build.*
>
> *As a nation, we have too much information to be short-sighted about this. We have good data, we have far-reaching science, we have experience, we have knowledge. We need to put that knowledge to good use and leverage those strengths, not avoid what is confronting or 'too hard'.*

Its not just Aotearoa New Zealand, either. The international earthquake resilience fraternity is truly global, and Te Hiranga Rū QuakeCoRE has an enviable reputation that continues to flourish. But we still have work to do with communities back home, and the Board is conscious that mātauranga Māori, in particular, is an area where we can be stronger.

Te Hiranga Rū QuakeCoRE is in great shape and I am grateful for the oversight and advice of Board members Tā Mark Solomon, David Brunsdon CNZM, Ian Wright, Wendy Saunders, Richard Clarke and Ellen Rathje. I especially would like to thank Director Brendon Bradley and Operations Manager Ruth Hartshorn for their mahi. Kia ora.

On behalf of the Board, we are looking forward to an exciting next 12 months and beyond.

He toka tū moana, ara he toa rongonui [strong like a rock in the rapids]

Mike Mendonça, MBE
Board Chair

About Us

Te Hiranga Rū QuakeCoRE is transforming the earthquake resilience of communities and societies, through innovative world-class research, human capability development and deep national and international collaborations. As a Centre of Research Excellence funded by the New Zealand Tertiary Education Commission, QuakeCoRE is a national network of leading Aotearoa New Zealand earthquake resilience researchers. QuakeCoRE is hosted by the University of Canterbury and has eleven other formal partners.

We enhance earthquake resilience across the country and internationally, by working collaboratively on integrated, multi-disciplinary programmes of world-leading research. Our research supports the development of an earthquake-resilient Aotearoa New Zealand.

Our Vision

We are creating an earthquake-resilient Aotearoa New Zealand where thriving communities have the capacity to recover rapidly after major earthquakes through mitigation and pre-disaster preparation informed by research excellence.

Our Outcomes

1 **Improved Earthquake Resilience**
We will contribute to a step-change improvement in the earthquake resilience of the nation's infrastructure from research-informed national and local policies, implementation standards and disaster planning.

2 **Improved Economic and Commercial Outcomes**
We will support Aotearoa New Zealand's long-term economic benefit through significantly improved seismic performance of New Zealand infrastructure, rapid business recovery after future earthquakes and the growth of engineering resilience, innovation and business in the New Zealand construction sector driving international competitiveness.

3 **Improved Societal Outcomes**
We will enable communities to recover rapidly after major earthquakes through mitigation and pre-disaster preparation, informed by research and public engagement.

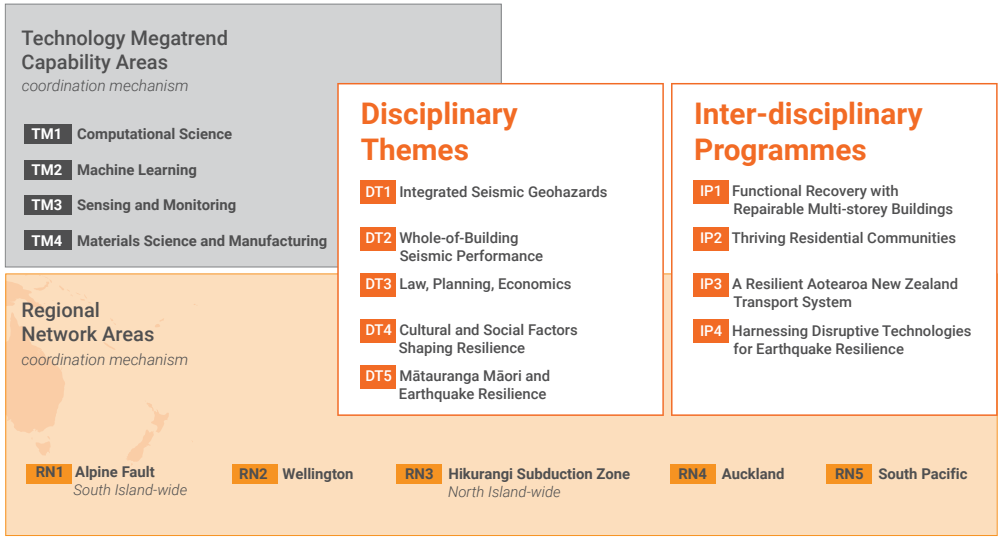
4 **Highly Skilled and Diverse Workforce**
Our graduates will be sought after for their knowledge of earthquake resilience and work-ready professional skills. They are taught in the very best national and international multi-disciplinary environment, combining research and industry elements. Through our graduates, we will seek a growth in under-represented groups (Māori and Pasifika) and gender equality in engineering disciplines.

5 **International Recognition**
We will be a focal point for international earthquake resilience, attracting the best talent and business alongside national and international research collaborations.

6 **Growing Mātauranga Māori**
We will contribute by building close engagement with Māori leaders who have responsibility for earthquake planning and resilience and developing opportunities for Māori capability building. The distinctive contribution of Māori indigenous knowledge of earthquake resilience will enhance social, economic and environmental outcomes for Aotearoa New Zealand.

Research Programme

Our research programmes are advancing the science and implementation pathways of earthquake resilience through system-level science with highly integrated collaborations coordinated across the physical, engineering and social sciences and across multiple research institutions. The research is principally organised into Disciplinary Themes, Inter-disciplinary Programmes and Coordination Mechanisms.



The **Disciplinary Themes** collectively span the disciplinary pipeline of earthquake resilience and focus on transformative research questions in which Aotearoa New Zealand researchers have shown global leadership.

The **Inter-disciplinary Programmes** bring together the diverse QuakeCoRE community through research questions that leverage New Zealand's unique environment and challenges toward the grand challenge of an earthquake-resilient New Zealand.

The **Coordination Mechanisms** (Technology Megatrend Capability Areas and Regional Network Areas) accelerate the development of human capability in emerging technologies for leading-edge research and regional networks, for both illustrating the application of research and working with partners and stakeholders to implement our research into tangible resilience advances.

Disciplinary Themes

DT1 **Seismic demands and consequent geohazards**

Programme Area Leaders: Brendon Bradley, Rolando Orense & Tim Stahl

Advance understanding and modelling of individual earthquake-induced geohazards (ground motions, liquefaction, and slope instability), as well as unified data collection and modelling approaches to enable an integrated prediction in order to more efficiently mitigate future impacts and stimulate rapid advances in the profession.

DT2 **Whole-of-building seismic performance**

Programme Area Leaders: Rick Henry & Santiago Pujol

Develop fundamental understanding, and methods and models for the quantification of, whole-of-building seismic performance through direct consideration of structural and non-structural component interactions, as well as advances in seismic design and assessment considering life-cycle analysis.

DT3 **Planning, law & economics**

Programme Area Leaders: Ilan Noy & John Hopkins

Investigate economic impacts of earthquakes, and create the evidence base to inform regulation for effective planning, policy and mitigation to build resilience – including whole-of-economy earthquake impact modelling, assessment of specific resilience-building legal and planning tools and processes, and behavioural 'nudges' to incentivize resilience.

DT4 **Cultural and social factors shaping resilience**

Programme Area Leaders: David Johnston & Caroline Orchiston

Collaboratively understand, model and improve the critical cultural and social factors determining societal resilience to earthquakes in Aotearoa New Zealand, including human responses to earthquakes, temporal and spatial variation of risk, and building an earthquake-resilient society.

DT5 **Mātauranga Māori and earthquake resilience**

Programme Area Leaders: Anthony Hoete, Christine Kenney & Tūmanako Fa'aui

Community-led and co-designed participatory research to create and innovate mātauranga Māori (Māori knowledge) that will facilitate achievement of the earthquake resilience aspirations of tangata whenua. Knowledge translation of research findings will encourage increased understanding within Te Hiranga Rū QuakeCoRE, of iwi, hapū and whānau perspectives on earthquakes and disaster risk reduction.

Inter-disciplinary Programmes

IP1 **Functional recovery with repairable multi-storey buildings**

Programme Area Leaders: Geoff Rodgers & Alice Chang-Richards

Repair of earthquake damage is a critical component to the recovery after an earthquake disaster. After recent events, the time to return the commercial and industrial building stock to functionality has been hindered by the lack of understanding of residual capacity and repair. This programme will identify time-to-functionality targets and repairable building solutions, thus providing the underlying science to support the development of the world's first functional recovery-based seismic design standard.

IP2 **Thriving residential communities**

Programme Area Leaders: Tim Sullivan & Julia Becker

The Canterbury earthquakes illustrated the potential for large financial losses ($16B of $40B total) and multi-year disruption to Aotearoa New Zealand's residential sector, with significant implications on mental health and the disaster insurance market. This programme will tackle the problem of resilient housing – including effective engineering and technological solutions, land-use planning, improved insurance processes and frameworks, effective legislation, and communication and engagement strategies.

IP3 **A resilient Aotearoa New Zealand transport system**

Programme Area Leaders: Liam Wotherspoon & Charlotte Brown

A resilient transport and logistics system is critical to the ongoing and future viability of businesses and communities across the country, supporting the efficient movement of goods and people. This programme will integrate component- and system-level modelling of networks and their users, consider interaction between different transport and logistics modes, and the social and economic impacts of disruption, to inform policy and investment decisions on the transport and logistics systems of the future.

IP4 **Harnessing disruptive technologies for seismic resilience**

Programme Area Leaders: Nirmal Nair & Garry McDonald

This programme will identify how transformational (i.e. order of magnitude) advancements in Aotearoa New Zealand's infrastructure resilience can be achieved through strategic adoption of disruptive technologies, via government and market-led initiatives. A central hypothesis is that rapid adoption of several disruptive technologies (e.g. distributed solar power) will result in a significantly greater resilience gain than the conventional wisdom of incremental investment to improve existing asset classes (e.g. centralized transmission networks).

Coordination Mechanisms

Technology Megatrend Capability Areas

Research technologies provide a platform upon which leading-edge research can be undertaken. Our Capability Areas will accelerate the depth and extent of adoption by researchers in the Disciplinary Themes and Inter-disciplinary Programmes, and thus harness their transformative potential toward the earthquake resilience mission.

The four Technology Megatrend Capability Areas are:

- **TM1** Computational Science
- **TM2** Machine Learning
- **TM3** Sensing and Monitoring
- **TM4** Materials Science and Manufacturing

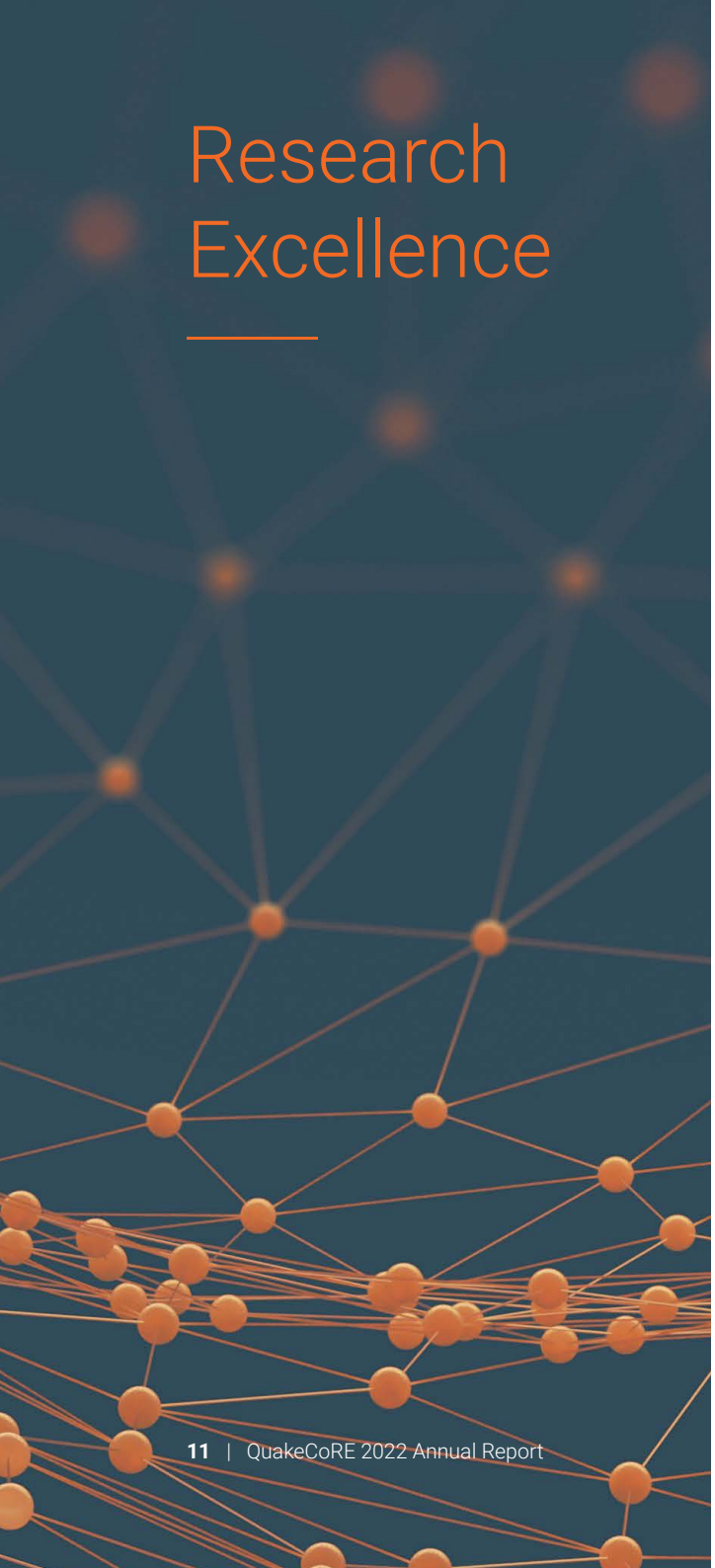
Regional Network Areas

The Regional Network Areas act as a focal point to provide contextual relevance and rapid embedding of research solutions. They provide a pathway for the application of our research and the collaboration with partners and stakeholders to translate research outcomes into tangible advances in earthquake resilience.

The five Regional Network Areas are:

- **RN1** Alpine Fault (South Island-wide)
- **RN2** Wellington
- **RN3** Hikurangi subduction zone (North Island-wide)
- **RN4** Auckland
- **RN5** South Pacific

Research Excellence



Acts at Odds

The magnitude 7.8 Kaikōura Earthquake of 2016 gave Aotearoa New Zealand more surprises than just trembling ground in the middle of the night. For Wellingtonians, one of the disturbing outcomes was damage to modern office buildings. Constructed under the Building Act 2004, these buildings should have been safe for workers. The earthquake made it clear; they were not.

For Toni Collins at the University of Canterbury's School of Law, it was damage to Statistics House that really concerned her. She'd been looking at the definition of an Earthquake Prone Building (EPB) in the Building Act and was struck by how specific it was. What if buildings didn't tick obvious boxes for being earthquake-prone but were still vulnerable? Statistics House, built in 2005, proved that such buildings exist: it was so badly damaged in the earthquake it had to be demolished.

Under the Building (EPB) Amendment Act 2016, owners of EPBs, as identified by local authorities, are required to have their buildings seismically assessed. So how do people know they will be safe in all other buildings? That's what led Toni to look at the Health and Safety at Work Act 2015. Under this Act all business owners must ensure their workplace buildings will not cause harm to occupants. And this includes ensuring their buildings will not fail in earthquakes. But it is not clear that these owners should have their buildings seismically assessed. The two Acts are at odds so how do building owners know what to do?

An essential part of effective earthquake resilience and disaster recovery is law. Te Hiranga Rū QuakeCoRE partners with the Institute of Law, Emergencies and Disasters (LEAD) to research improvements to the legal framework around disaster risk reduction.

Collins, with her colleague Nadia Dabee, scoured the literature, court cases and government websites to clarify the Government's intention. Even a WorkSafe Policy Statement issued in 2018 to explain the overlap between the two Acts, only confused the situation. Many owners don't realise they are responsible for getting seismic assessments. Others are closing buildings unnecessarily. This is because the law is unclear.

Toni and Nadia have published their research in the *New Zealand Universities Law Review*. They call for the higher standard of the Health and Safety at Work Act to be applied as this will give occupants the highest level of protection under the law regarding building safety.

Toni, having lived through the Christchurch earthquakes, is adamant that more needs to be done. “We live in the Shaky Isles. We need to ensure our buildings are up to the job of keeping people safe.” Toni would like to see a building warrant of fitness introduced with regular checks by experts and displaying of building status. She understands it’s very hard for building owners facing large costs. But that shouldn’t stop New Zealand having a robust system in place. “The safety of people must be our priority. We should all be safe in the buildings in which we work.”

Toni Collins. Image credit: University of Canterbury

Earthquake Casualties

Drop. Cover. Hold.

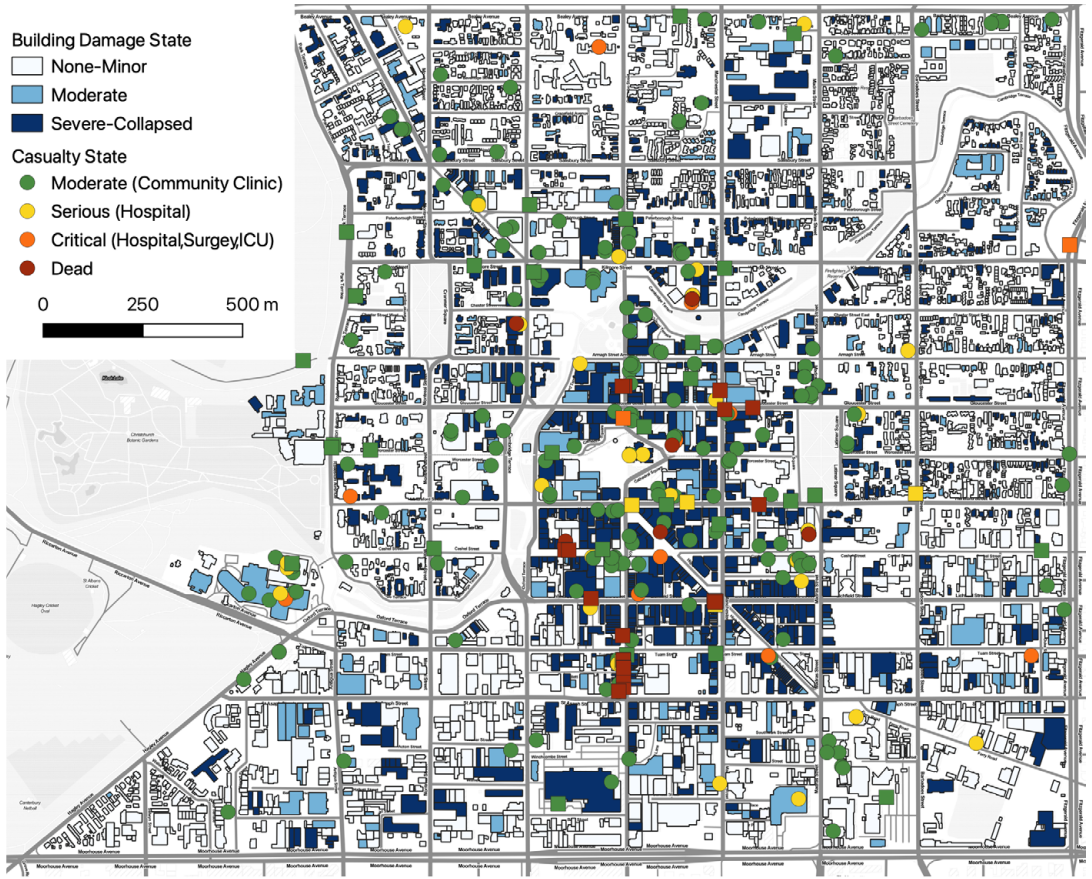
This is the safest course of action when the ground starts shaking – and now, there's further research to reinforce it.

Nick Horspool, Risk Specialist at GNS Science, has recently completed a Te Hiranga Rū QuakeCore PhD. His thesis has been recognised as of "exceptional quality in every respect" by being placed on the Dean of Graduate Studies Honours List at the University of Auckland.

Nick analysed records of injuries and deaths from the Canterbury Earthquake Sequence and the Kaikōura Earthquake in Aotearoa New Zealand. He wanted to know exactly what causes people to be injured or killed in earthquakes. Usually, it's not the earthquake itself that causes casualties, but interactions between shaking, buildings, and people. As we remember all too clearly, it was building collapse in Christchurch that led to most deaths. And it turns out that people's behaviour led to most injuries.

Nick believes, "If we can better understand key risks for deaths and injuries from earthquakes, then we can be more successful at reducing those risks".

Nick worked with a multidisciplinary team of health professionals, engineers, and social scientists to build a statistical model that forecasts deaths and injuries from future earthquakes. Forecasting casualties enables pre-earthquake planning and risk mitigation to be better targeted, and appropriate emergency and health responses to be mounted immediately post-earthquake.



Building damage and casualty location in the Christchurch Earthquake. Image supplied

The model is built from more detailed information than previously available. Data sources include claims to the Accident Compensation Corporation, follow-up surveys of individuals, health board records and coronial inquiries.

The most challenging part of the project was bringing multiple components into a logical framework. Unlike previous earthquake casualty models, this new tool takes a multivariate approach by considering seismological, engineering, behavioural and socio-economic factors.

The earthquake casualty model is now available as part of RiskScape. Nick hopes it will help society get better at protecting people's lives. It can be used to run a variety of scenarios and will be valuable for other countries with building codes like ours. It will also be useful for cost-benefit analysis of mitigation actions such as education, early warning systems, retrofitting and upgrading building codes.

"Strengthening buildings is crucial for reducing deaths. Before the Christchurch earthquakes, we didn't have much data to demonstrate how well our building codes were doing. Now it's clear we need building codes based on fatality risk rather than level of shaking."

Another key finding was that "People's actions are really important." Sixty percent of injuries were caused by people falling or grabbing on to something – injuries that wouldn't have happened if official advice to "drop, cover, and hold" had been followed. Females were twice as likely to be injured as males which may be due in part to their instincts to move and help children. But the best thing we can all do to help ourselves and others is…
Drop. Cover. Hold.

Nick Horspool. Image supplied

Material Connections

Claire Pascua has a knack for making connections. She was drawn to her PhD topic – investigating connections between concrete walls and steel frames – because it looked challenging. And, sure enough, the interactions between these two common engineering materials have kept her busy over the last few years.

Claire's research stems from the increasing construction of hybrid buildings – those that use several materials in their structure. Typically, structural systems comprise a single material, such as concrete, steel, or timber. However, combining concrete walls and steel frames creates an efficient and economical system, allowing smaller members, shorter floor heights, built-in fire protection, and faster construction time.

Aotearoa New Zealand has separate design standards for concrete buildings and steel buildings but no explicit guidelines for combining the two. There is little research on how concrete walls and steel frames interact when used together, especially during earthquakes.

At the University of Auckland Structural Testing Laboratory, Claire conducted a series of tests on four full-scale concrete wall-to-steel beam connections, incorporating design practices by New Zealand engineers. She added floor slabs to her specimens – something not commonly done in previous studies – and subjected them to seismic and gravity loading.

Claire Pascua testing concrete-steel connections.
Image supplied

Contrary to design assumptions, Claire's specimens failed suddenly in a brittle manner by concrete breakout, demonstrating that the design needs improvements. Claire also tested some design variations and found that slotted holes in the web plate and a different anchorage system made improvements but still failed in a brittle manner. She is currently conducting numerical modelling to see how these connections impact the performance of a whole building.

While Claire believes that combining concrete walls and steel frames is a promising building solution, it is crucial to get the connections to behave as intended. With her supervisors, she aims to develop design guidelines to help engineers make better connections. "Imagine if we could live in buildings that wouldn't be damaged in earthquakes: that is the future I want to see."

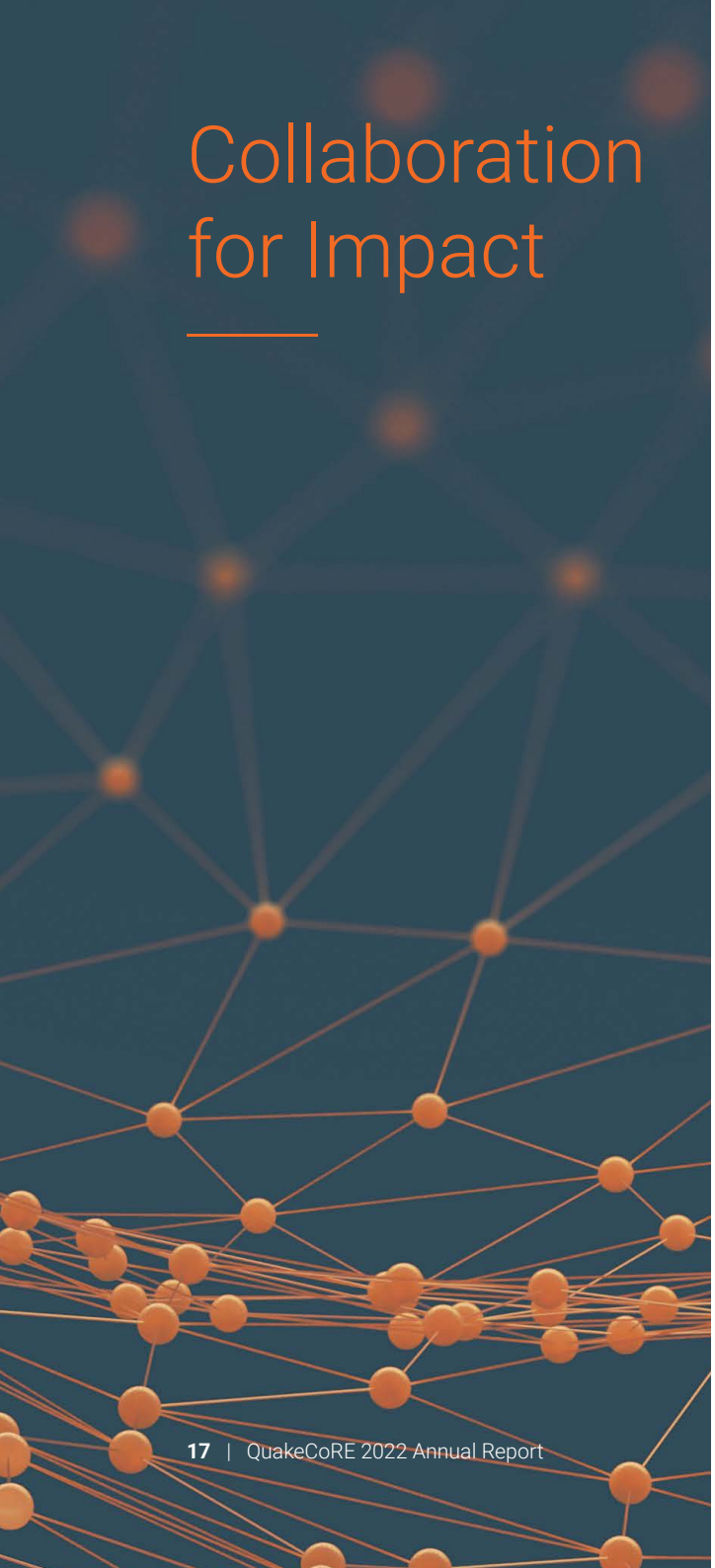
Claire has enjoyed bridging the gap not only between hybrid connections but also between her supervisors. Her main supervisor, Rick Henry, specialises in concrete, while her co-supervisor, Charlotte Toma, specialises in structural design, and she gets advice on steel from Charles Clifton. She has found it valuable navigating different ways of thinking in various areas of expertise.

Claire enjoys the challenges of academia, "I really like that brief moment when I'm the only one who knows something". Yet, she is also enthusiastic about sharing her research—having joined and occasionally won science communication competitions such as the Three Minute Thesis and QuakeCoRE Lightning Talks.

The other kind of connection Claire likes making is with people. Coming from the Philippines, she enjoys the lack of hierarchy in New Zealand and appreciates how Te Hiranga Rū QuakeCoRE supports student involvement. She found it fascinating that QuakeCoRE actively promotes different institutions and disciplines working together. And now, having been involved with QuakeCoRE throughout her PhD, she feels like she has valuable connections all over the country.

Wall connection plates. Image supplied

Collaboration for Impact



ShakeOut Together

Every year in October the Minister of Emergency Management, Civil Defence officials, scientists and community leaders visit a primary school to join the students and teachers in spending a minute curled up on the floor with their hands covering their heads. At the same time hundreds of thousands of people around the country are doing exactly the same thing.

This is Whakahaumaru Aotearoa New Zealand ShakeOut. In 2022 New Zealand celebrated the tenth anniversary of this nationwide earthquake drill. Designed to teach people the safest actions to take during an earthquake, and to practise them, ShakeOut is run by the National Emergency Management Agency (NEMA) in partnership with Toka Tū Ake EQC.

Getting down to the floor, covering your head and neck, and holding your position until the shaking stops – **drop, cover, and hold** – are the best actions to take in an earthquake because they minimise your chances of falling over or being hit by moving objects. Anything that reduces injuries in a disaster is good news, so running a nationwide earthquake drill is a worthwhile endeavour.

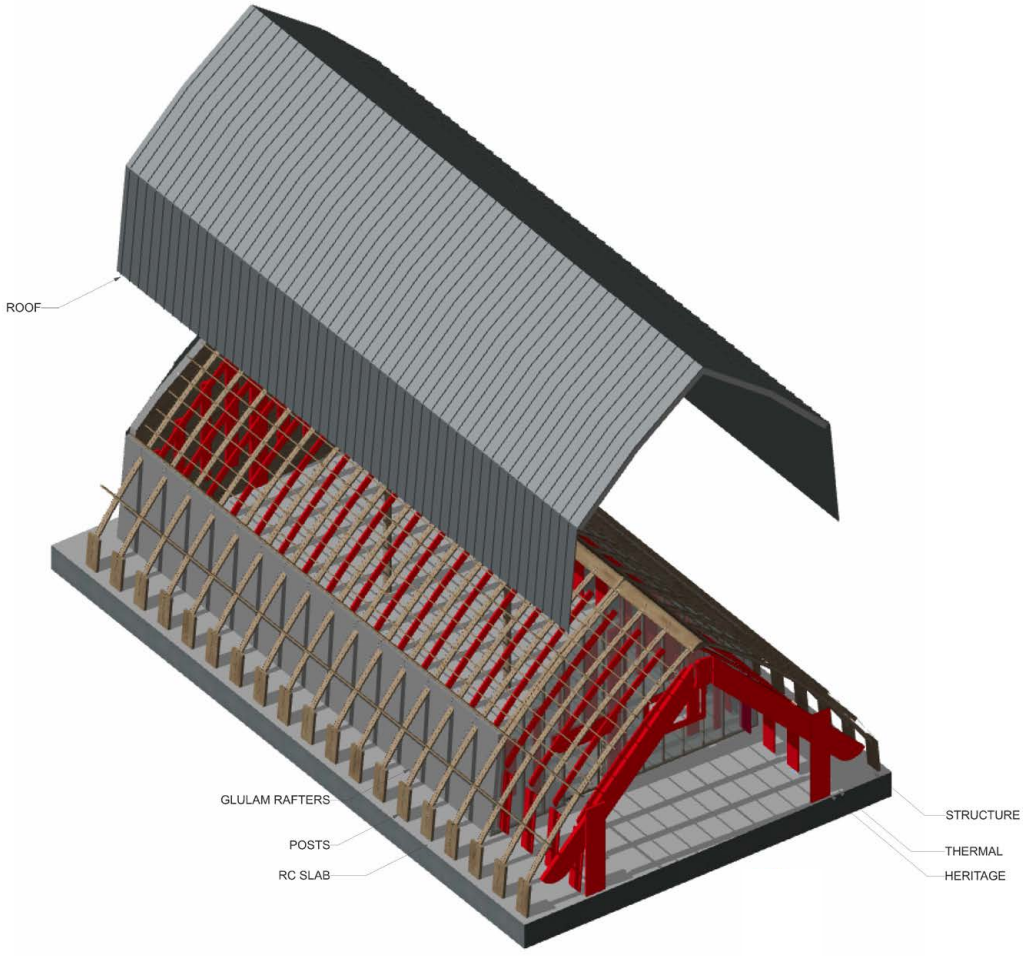
But does participating in ShakeOut change people's behaviour? Lauren Vinnell, Julia Becker, and other Te Hiranga Rū QuakeCoRE researchers at the Joint Centre for Disaster Research (JCDR) have been delving into the effectiveness of ShakeOut drills. They surveyed participants and compared their earthquake preparedness with people who haven't joined a ShakeOut exercise.

Their research shows that people who participate in ShakeOut are more likely to know the correct actions to take and to use them during a real earthquake. Not only that, but they're more likely to be better prepared for earthquakes at home and at work.

JCDR works with NEMA and Toka Tū Ake EQC to continually improve the effectiveness of ShakeOut. This collaboration ensures that ShakeOut is informed by the latest research. Making ShakeOut an annual event, adding a tsunami hīkoi, including messages about what to do in different contexts, and advising on additional emergency preparations are examples of how ShakeOut has evolved over time. Future goals are to make ShakeOut more accessible for disabled and elderly participants.

With a background in psychology, Lauren knows, “People are more likely to do things if they know there are benefits for doing it. If there are multiple benefits, even better. So, we let people know that by participating in ShakeOut, they’re more likely to be safe in a real event. And that it can be easy and fun to participate.” Doing ShakeOut together with people in your household, workplace or community makes it more enjoyable. There’s a sense of joint purpose that overrides any embarrassment you might feel about diving under a chair or desk. And having practised it, you’re more likely to do it again when it really matters.

Civil Defence mascot Stan with Julia Becker and Lauren Vinnell at the 2022 Whakahaumaru Aotearoa New Zealand ShakeOut. Image credit: Joint Centre for Disaster Research



Next Generation Māori Buildings

Ki te kotahi te kākaho, ka whati; ki te kāpuia, e kore e whati.
If a reed stands alone, it can be broken; if it is in a group, it cannot.

A team of academics, professionals, and community members have come together to breathe new life into a significant element of Aotearoa New Zealand's built heritage. Their collaborative mahi will see a building that hasn't stood for over 90 years re-stand again, not by replicating the original, but by propelling traditional Māori construction practices into a contemporary building project.

Erected in the 1870s by Hira Te Popo, chief of Ngāti Ira, Tānewhirinaki was one of the largest and most elaborately carved wharenui of the time. Standing at the entrance to Waioweka Gorge, it looked over the plains of Ōpōtiki, where 144,000 hectares had been confiscated from Te Whakatōhea iwi by the Crown. The building was a way of rebuilding the mana of Ngāti Ira after land confiscations had devastated a previously prosperous and peaceful hapū.

Whare Tānewhirinaki has had a turbulent history. It has gone from the heights of being a symbol of Ngāti Ira culture and designated a whare karakia (church) by Te Kooti, to the depths of being dismantled after the 1931 Napier Earthquake and having its whakairo (carvings) removed to Auckland.

Upper: Tānewhirinaki. Image credit: Clark, Charles Troughton, 1890-1973. Carved house "Tanewhirinaki" at Waioeka. McDonald, James Ingram, 1865-1935: Photographs. Ref: PAColl-0477-01. Alexander Turnbull Library, Wellington, New Zealand. records/23010202

Lower: Plans for Tānewhirinaki. Image supplied

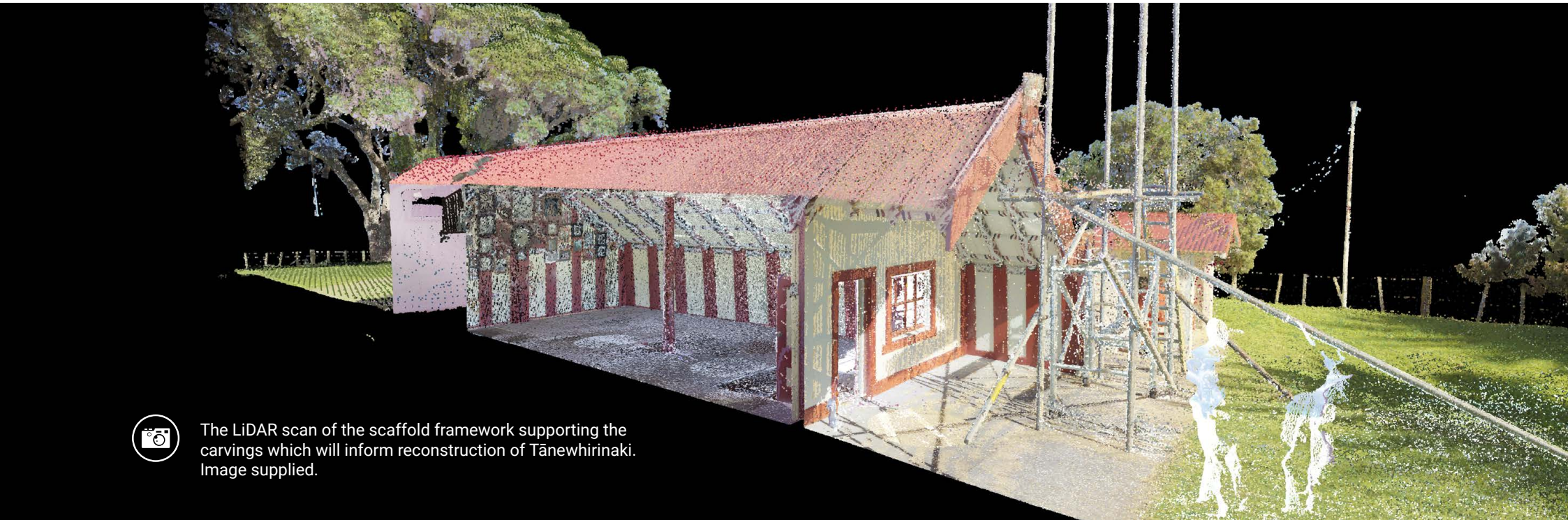
In 2009 the whakairo, which embody the hapū's ancestors, were returned. In 2015, a one-third scale model of Tānewhirinaki was made by Jeremy Treadwell as part of his PhD research. He explored mīmiro, a post-tensioning system in which the tāhuhu (ridge beam), heke (rafters), and poupou (wall posts) were integrated to create a compressive arch, structurally resilient to external forces. This sophisticated Māori construction technique was all but lost with the arrival of European fixings such as nails.

The research team of Ngāti Ira (including descendants of Hira Te Popo), architects, and engineers, are collaborating to revive this endangered knowledge. Anthony Hoete, Professor of Architecture at the University of Auckland, partnering with Te Hiranga Rū QuakeCoRE, Toka Tū Ake EQC, and Oxford Brookes University, is aiming to replicate the construction principles of mīmiro with modern materials. He hopes that mīmiro technology can be applied beyond wharenui to inform the design and construction of medium density housing.

Plans are well-advanced for building full-scale, proof-of-concept portals on location at Opeke Marae. Digitally cut laminated timber will be used instead of hand-adzed solid timber and, in homage to the boat-building origins of whare, tensioning materials will include winches, cleats, and sailing rope. The portals will be subjected to simulated earthquake shaking to predict the performance of the future state-of-the-art structure being proposed to house the whakairo in the next stage of the project.

The new Tānewhirinaki will be an example of what Hoete calls high-tech Māori architecture. The structure protects internal treasures. Yet, like the Centre Pompidou in Paris or Lloyd's Building in London, the structural technology and services will be expressed on the building's exterior.

One hundred and fifty years after Tanēwhirinaki first stood, Te Whakatōhea has agreed to accept a $100m Treaty settlement from the Crown. The timing of this is poignant. It feels like Tānewhirinaki will rise again soon.



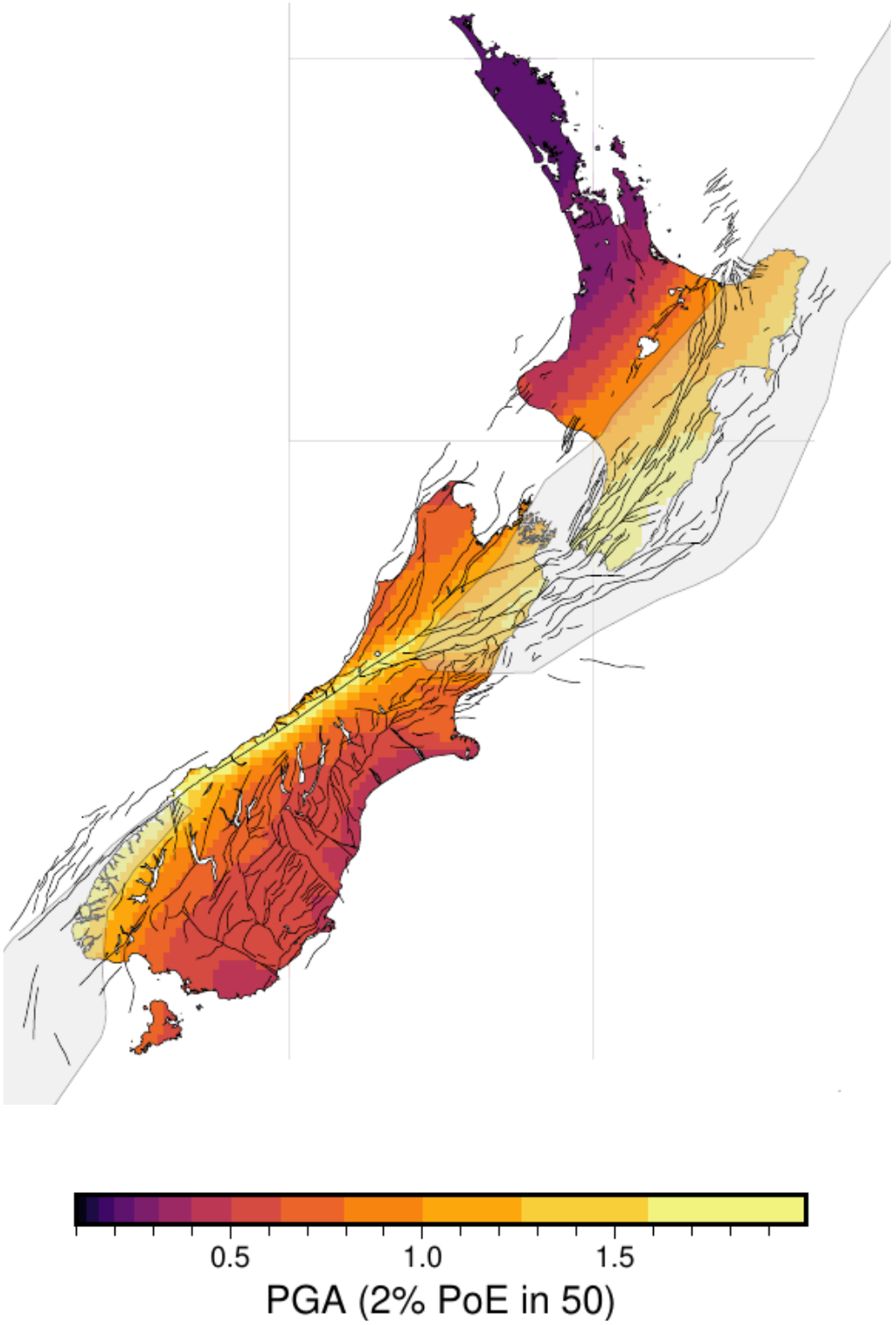
The LiDAR scan of the scaffold framework supporting the carvings which will inform reconstruction of Tānewhirinaki. Image supplied.

Triumph of Collaboration

Aotearoa New Zealand's best estimate for how much and how often the ground will shake in future earthquakes comes from Te Tauira Matapae Pūmate Rū i Aotearoa, the National Seismic Hazard Model (NSHM). A new version of the model was released in October 2022 showing, on average, a 50% increase in hazard over the previous model published a decade earlier. While we may not feel like celebrating the higher hazard, we can celebrate that we now have an up-to-date, state-of-the-art understanding of earthquake hazard across the country.

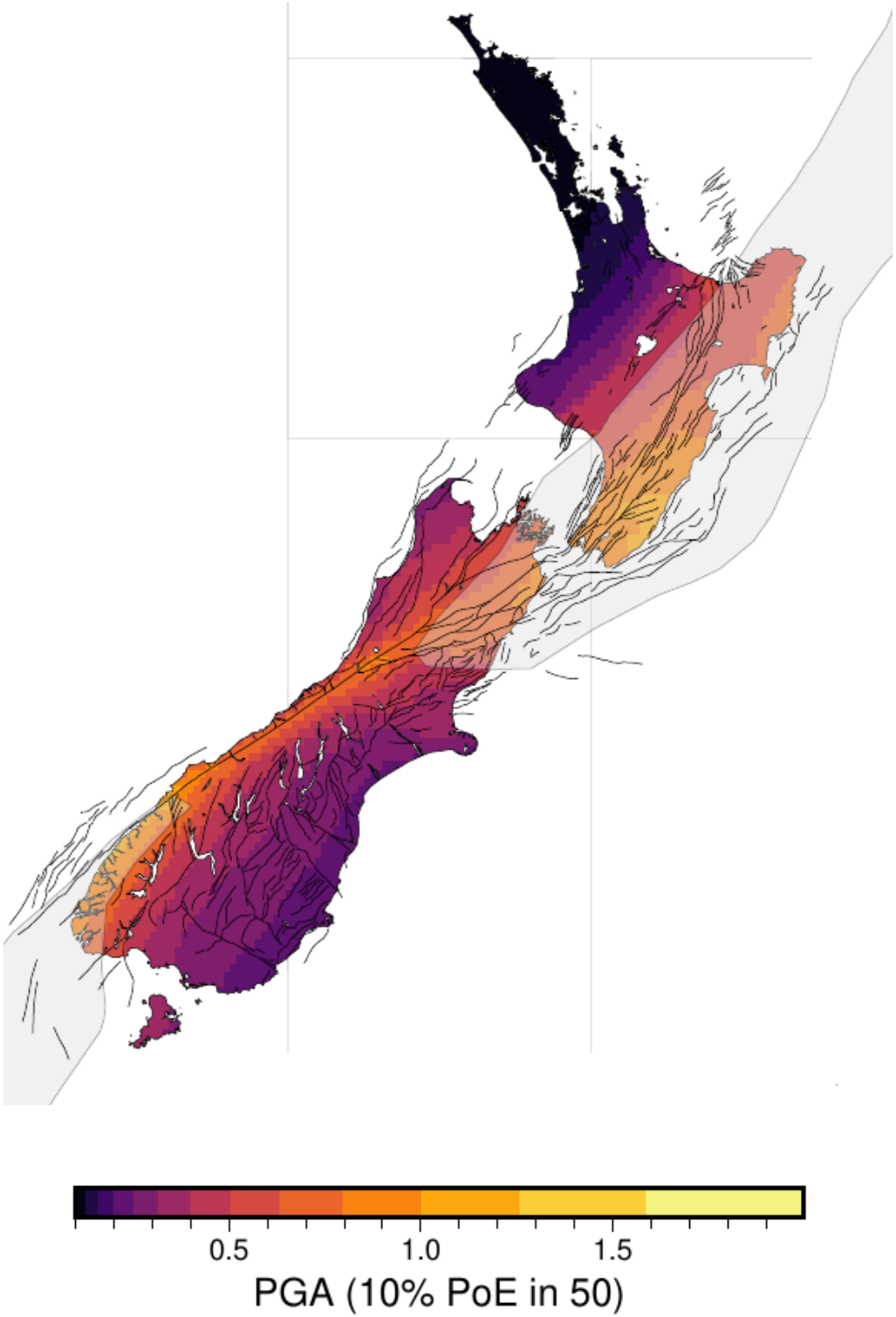
Led by GNS Science, and funded by the Ministry of Business, Innovation, and Employment and Toka Tū Ake EQC, this update to the NSHM was not a trivial piece of work. Given the increased understanding of earthquake science over the last decade, the development of new modelling techniques, improved computing capability, and the requirement for a robust, peer-reviewed process, there was a lot of work to do.

The solution lay in broad collaboration. Over 50 scientists from 15 institutions and 5 countries worked on the update with many New Zealand participants being Te Hiranga Rū QuakeCoRE investigators. This meant diverse research fields and leading-edge technology could be incorporated into the model



These maps show the **strength** of shaking and **how likely** it is that this level of shaking will occur within the next 50 years. The dark purple colours are weak shaking and the light orange and yellow colours are strong shaking. The scale bar shows peak ground acceleration (PGA) measured in g (1g is equal to gravitational acceleration on Earth). The thin black lines and grey shaded areas show the faults and subduction zones (respectively) that went into creating the model.

Right: There is a 2% chance of experiencing this level of shaking in the next 50 years. Image supplied



alongside traditional approaches. A technical advisory group of engineers, policymakers, insurance brokers and scientists worked together to ensure the output was best available science and as useful as possible for end-users. The new NSHM is like the trunk of a tree. Below ground is an extensive network of roots – these are inputs like earthquake activity of different faults and how seismic waves shake the ground in different areas. Some of the inputs are models themselves, and have multiple dimensions of space, time, earthquake physics, and associated uncertainties.

Mathematical logic, and our understanding of earthquake occurrence, bring this intense tangle of roots into a coherent trunk to provide a rigorous estimate of seismic hazard that does justice to current knowledge.

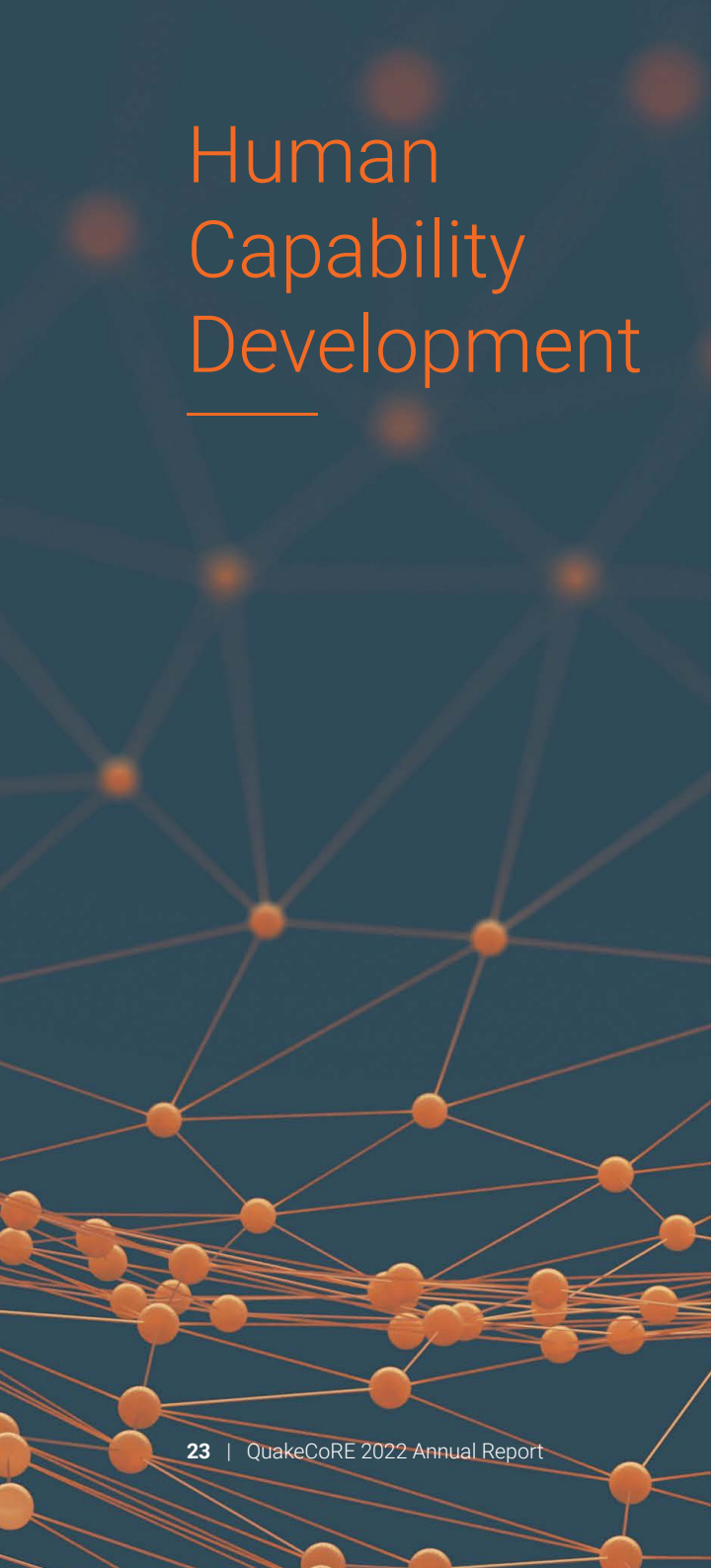
The result is a nationwide increase in seismic hazard we can't ignore. Regional breakdowns show most regions have either the same or an increased level of hazard, and some regions have twice to three times their previous level. The increase arises mainly from new ways of estimating how the ground surface will behave during earthquakes. Ground conditions have a big impact on the level of shaking and can vary greatly within a city. Improved modelling of the Hikurangi Subduction Zone and complex earthquake sources have also contributed to the increase.

The many and varied uses of the NSHM form the canopy of the tree. The trunk feeds into the branches by informing engineering standards for buildings; guiding risk assessments for policy-making, insurance, land-use planning; supporting emergency management, business continuity planning, and community resilience. Let's hope this NSHM update leads to a profusion of foliage so that earthquake mitigation measures keep pace with what we know of our seismic hazard.

While this new NSHM is already a triumph of collaboration, demonstrating world-leading approaches, its real success will lie in the actions taken towards New Zealand becoming a more earthquake-resilient nation.

There is a 10% chance of experiencing this level of shaking in the next 50 years.

Human Capability Development



Design for Emergencies

It was a catastrophic event that launched one Te Hiranga Rū QuakeCoRE scholar more rapidly into the field of disaster response than he'd anticipated. A day after the Hunga Tonga-Hunga Ha'apai eruption in January 2022, Matt Luani was called upon to help.

With ash falling in Tonga, there was an urgent need to communicate safety precautions for the Tongan diaspora in Aotearoa New Zealand who were mobilising support for their families, as well as the local Tongan population. Matt, via his supervisor Associate Professor Siautu Alefaio, found himself communicating with volcanologists, disaster managers, and Tongan community leaders who were working out how to get information to people on the ground in an accessible manner. Matt's training in graphic design enabled him to come up with an effective infographic for the ashfall advice.

Matt says, "There was so much energy to feed off. It was a good learning process for working in emergency response mode." He was amazed at what could be done in such a short time. The Tongan ashfall infographic was completed in about 48 hours, a project that would normally take weeks.

From a young age, Matt liked drawing. He took fine arts hoping to become a tattoo artist. He soon found that he was more suited to graphic design. But he never anticipated that his artistic abilities would take him into helping in emergencies.

Following his Master's degree in graphic design from Massey University, Matt worked as a designer for NIUPATCH. This is a Pacific research collective at Massey University's School of Psychology focused on disaster and humanitarian challenges within climates of change. Matt explains that NIUPATCH is the Pacific partner of the Joint Centre for Disaster Research. So, that's how he got involved with the Tongan eruption.

Matt knew nothing about emergency management, but he saw the opportunity, as a Pacific designer, for providing messaging and design infused with Pacific values. He found his niche. "I want to use design as a bridge to make all the information that's out there on disaster response and emergency management more accessible to Pacific communities."

“There is a lot of information out there in academic language. We need to put it into every day and Pacific languages alongside visuals, so we appeal to visual learners as well. And we need more of our people in this space.” Matt is the first Pacific student to receive a QuakeCoRE scholarship.

For his PhD research, Matt aims to explore a Pacific-centred design system he’s developed. He will then apply the framework to various design mediums such as infographics, podcasts, social media, and website design. Matt appreciates the open community that QuakeCoRE provides. He looks forward to reaching out and showcasing his work.

At the heart of his work is faith and serving his community. Matt was brought up with service as a core value, so he feels very blessed to be able to stay in academia, use his skillset, and help people at the same time.

Matt Luani. Photo supplied

Opportunities for Students

From the seismically sleepy lowlands of Germany to the quaky archipelago of Aotearoa New Zealand, Amelia Lin has traversed a steep learning curve to be doing the hazard research she is doing today. She obtained a Master's in Civil Engineering in Berlin, but it wasn't until she studied in Taiwan that she had even heard of earthquake engineering, "It really triggered something in me". She started seeking out places with earthquakes. "New Zealand popped up as a place with so many researchers in this field and it was great that you could do a PhD paying domestic fees rather than international fees."

Amelia worked with global geospatial models, adapting them for New Zealand conditions, to see how useful they could be for predicting areas of liquefaction manifestation and landslides after earthquakes. She evaluated the models against observations from the Canterbury Earthquake Sequence and the Kaikōura Earthquake, and found they were useful for identifying exposed areas at both regional and national scales. Amelia applied the models to the State Highway network to estimate the impact of liquefaction and landslides on transport following various earthquake scenarios.

Amelia was impressed that what seemed like a simple research question ended up expanding out in many directions. She is now working on postdoctoral research at the University of Auckland that builds on her PhD.

Amelia Lin. Photo supplied

"During your PhD you're so focused on your research problem that you often forget about the bigger picture. The postdoc is a good opportunity to provide outputs that are more useful for real world application."

Throughout her PhD, Amelia engaged in the Te Hiranga Rū QuakeCoRE community. She presented at the Annual Meetings and monthly Flagship meetings and was always keen to engage with other researchers. This led to new collaborations and relationships with stakeholder groups. Amelia also took the role of Communications Officer for the Auckland QuakeCoRE Emerging Researchers' Chapter (QERC) in 2019 and 2020.

QERC was a group Amelia first attended with a friend to get to know other people. She didn't expect it to be so good for meeting people across New Zealand as well as across university departments. With several awards to her name, Amelia's QuakeCoRE involvement provided not only valuable experience and networking opportunities, but also some highlights for her CV.

And to balance all the work? Amelia does Latin dancing. She admits that dancing three times a week kept her sane towards the end of her PhD. She learnt it here in New Zealand and, although she loves Europe, research is keeping her here because there is far more earthquake-related work in New Zealand than Germany. So, for now, she's enjoying the peace, calm and kindness she finds in Aotearoa.

Rupture on the Papatea Fault near the coast across State Highway 1 and the railway following the 2016 Kaikōura Earthquake.
Photo credit: Dougal Townsend, GNS Science

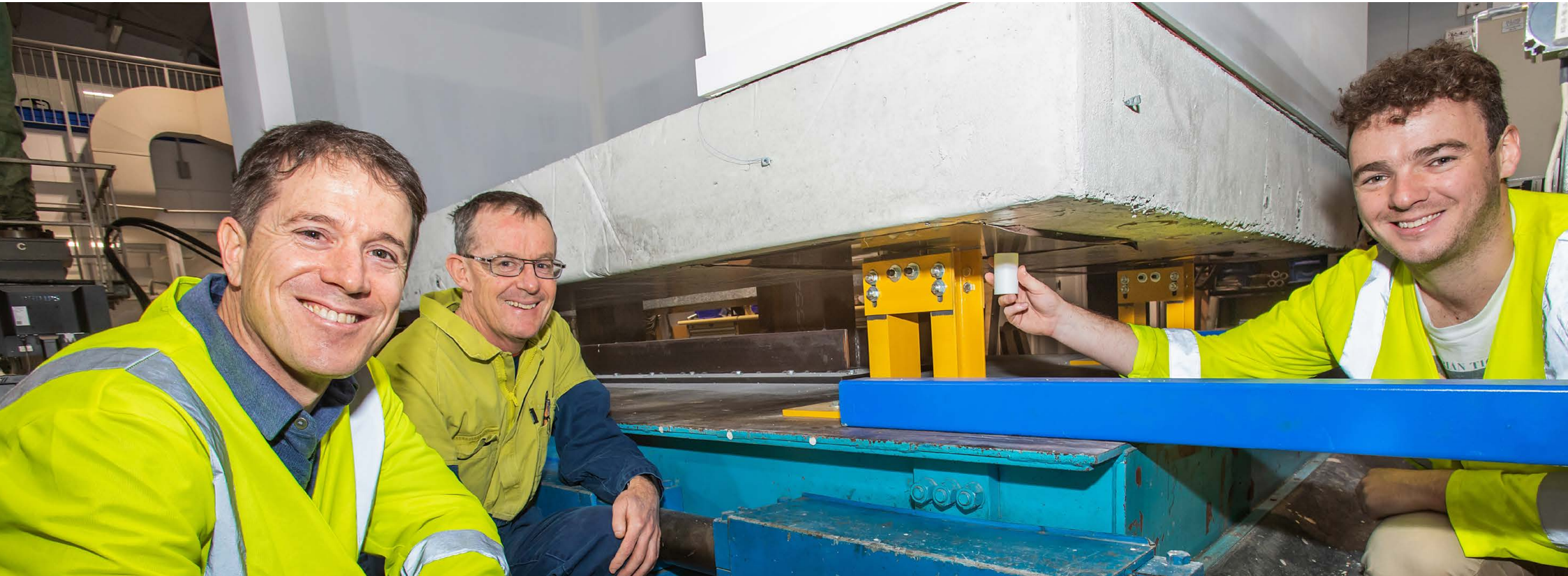
Scholar to Innovator

Aotearoa New Zealand houses are pretty good at not collapsing in earthquakes. But we have a long way to go when it comes to reducing earthquake-related damage. Following the Canterbury earthquakes, $16 billion was paid out by Toka Tū Ake EQC for damage to houses.

The magnitude of damage to residential buildings inspired engineers at the University of Canterbury to investigate mechanisms for protecting houses from ground shaking. Te Hiranga Rū QuakeCoRE scholar Tom Francis, with his supervisor Professor Tim Sullivan, set out to design and test a base isolation system for houses.

Base isolation systems, originally developed in Aotearoa New Zealand, enable a building to be separated from the ground during strong shaking, thereby minimising damage. Despite being well-proven, they've mainly been used in large public buildings because of the cost involved in construction and installation.

Tom and Tim, collaborating with Andre Filiatrault, a base isolation specialist in Italy, have come up with a way to make them cheap enough to use under houses. Tom says, "We've used similar materials but because houses are lighter than civic or commercial buildings, the forces on them in an earthquake



will be smaller, so we can scale everything down." All materials were sourced from local suppliers, and they worked with a residential builder to make sure construction methods were within normal building practice.

One of the challenges the team faced was that a house that's designed to slide around on Teflon pucks and stainless-steel surfaces in an earthquake, may also slide around in high winds. They overcame this by adding a concrete slab on top of the base isolators to make the house too heavy to be blown around.

So far, they've built a complete room on top of base isolators and tested the system on a shake table using earthquake records from the Darfield and Kaikōura Earthquakes as well as a hypothetical Alpine Fault Earthquake. There was no damage to the room and, perhaps even more importantly, wine glasses remained standing on the coffee table throughout the shake tests.

The obvious practical application of his research motivates Tom to get the base isolators under new houses. Partially funded by QuakeCoRE, Tom is now carrying out postdoctoral research to refine the residential base isolation system. He also has funding from KiwiNet's Emerging Innovator program so he can be trained and mentored for commercialising his research. Assuming the prototypes get through the next rounds of rigorous testing, and there's enough interest from the market, Tom would like to start a company selling the base isolators.

It's early days yet, but Tom likes the idea of being a company director. He's always been keen on applied engineering. He got interested in low damage design when he worked at Beca for a year, so the PhD topic was a good fit for him. Originally from Invercargill, Tom makes the most of living in Christchurch by traversing everything from the mountains to the sea – skiing in the Alps in winter and boating in Kaikōura whenever he's not shaking houses for a living.

Prior page: Tim Sullivan, John Maley and Tom Francis are keen to start manufacturing a base isolation system for residential houses. Image credit: University Of Canterbury

This page: Pictured (from left to right): John Maley, Tom Francis and Tim Sullivan testing the new base isolation system. Image credit: University Of Canterbury

Recognition Highlights

Paul Millar
(University of Canterbury)

The Royal Society Te Apārangi awarded Paul Millar from the University of Canterbury their annual award for distinguished service to aronui humanities. This award recognised Paul's commitment to growing capacity and expertise in Aotearoa New Zealand in digital humanities, which involves the intersection of digital technologies and humanities disciplines. Among his many research achievements, in 2011, he co-created the CEISMIC (Canterbury Earthquakes Digital Archive) which includes recorded earthquake narratives using the QuakeBox, a transportable recording studio. More recently CEISMIC has partnered with Te Hiranga Rū QuakeCoRE to study cultural and social factors shaping earthquake resilience.

Paul Miller at Te Apārangi award ceremony. Image supplied by University of Canterbury

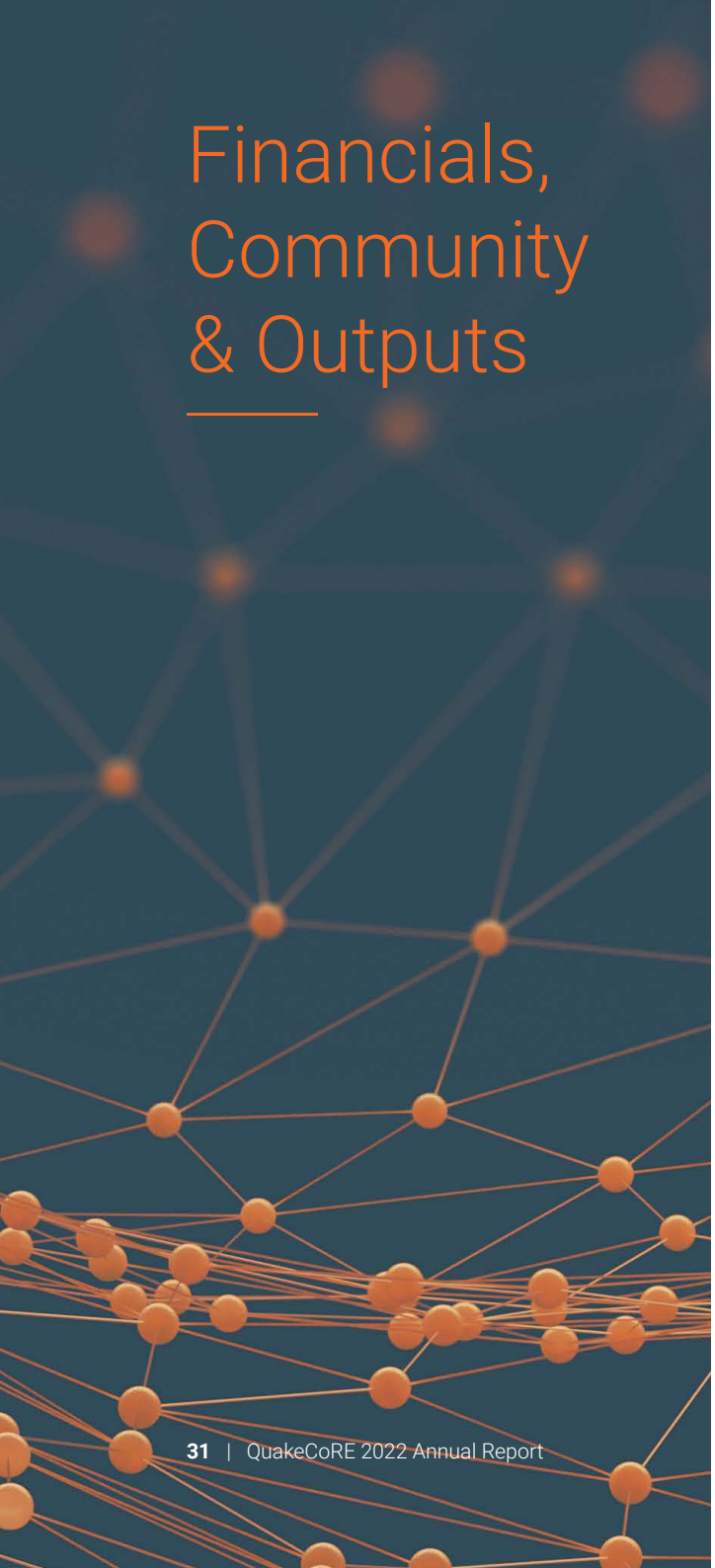
Charles Clifton

(University of Auckland)

Charles Clifton was recognised as a Distinguished Fellow by Engineering New Zealand Te Ao Rangahau for his contribution to earthquake engineering research in structural steel systems, as well as earthquake engineering practice in New Zealand. Charles has led the development and implementation of design guidance for using structural steel in buildings in Aotearoa New Zealand. His work has been hugely influential in the paradigm shift in multi-storey building design and construction, leading to lighter, safer, more resilient and more repairable buildings.

Charles Clifton. Image credit: Billy Wong, University of Auckland Photographer: Media Production. Image supplied

Financials, Community & Outputs



Financials

Category	Total ($000s)
CoRE Funding	4,200
Total Revenue	**4,200**
Directors and Principal Investigators	328
Associate Investigators	0
Postdoctoral Fellows	124
Research Assistants	52
Others	269
Total Salaries & Salary-related Costs	**773**
Overheads	736
Project Costs	597
Travel	231
Postgraduate Students	970
Equipment Depreciation / Rental	0
Subcontractor(s)	0
Total Other Costs	**2,534**
Total Expenditure	**3,307**
Net Surplus / (Deficit)	**893**

2022 at a glance

Category	Detailed category	FTE	2022
People	Principal Investigators	1.45	21
	Associate Investigators	0.00	81
	Postdoctoral Fellows	0.77	5
	Research Technicians	0.85	5
	Administration/Support	2.56	4
	Research Students	85.17	102
	Total	**90.80**	**218**
Peer-reviews research outputs	Books		1
	Book Chapters		5
	Journal Articles		56
	Conference Proceedings		29
	Total		**91**
Commercial activities	Number of Licenses		0
	Patents Applications		0
Students studying at CoRE by level	Doctoral Degree		80
	Masters		22
	Other		0
	Total		**102**

Community

102
Investigators

30
Industry Affiliates

17
Affiliate Organisations

Board

Mike Mendonça (Chair)	
David Brunsdon	Kestrel Group
Richard Clarke	University of Auckland
Ellen Rathje	University of Texas at Austin
Wendy Saunders	Toka Tū Ake EQC
Tā Mark Solomon	
Ian Wright	University of Canterbury

International Science Advisory Panel

Ellen Rathje (Chair)	University of Texas at Austin
Jack Baker	Stanford University
Ann Bostrom	University of Washington
Shyh-Jiann Hwang	National Taiwan University
Juan Carlos de la Llera	Pontificia Universidad Católica de Chile
Tiziana Rosetta	University College London

Principal Investigators

Brendon Bradley (Director)	University of Canterbury
David Johnston (Deputy Director)	Massey University
Anthony Hoete (Pouwhakahaere Associate Director)	University of Auckland
Caroline Orchiston (Associate Director)	University of Otago
Julia Becker	Massey University
Charlotte Brown	Resilient Organisations
Alice Chang-Richards	University of Auckland
Tūmanako Fa'aui	University of Auckland
Rick Henry	University of Auckland
John Hopkins	University of Canterbury
Jason Ingham	University of Auckland
Christine Kenney	Massey University
Garry McDonald	Market Economics Research
Nirmal Nair	University of Auckland
Ilan Noy	Victoria University of Wellington
Rolando Orense	University of Auckland
Santiago Pujol	University of Canterbury
Geoff Rodgers	University of Canterbury
Tim Stahl	University of Canterbury
Tim Sullivan	University of Canterbury
Liam Wotherspoon	University of Auckland

Associate Investigators

Esther Aigwi	Auckland University of Technology (AUT)
Siautu Alefaio	Massey University
Hamish Avery	University of Canterbury
Sherif Beskhyroun	Auckland University of Technology (AUT)
Denise Blake	Victoria University of Wellington
Megan Boston	University of Waikato
Anna Brown	Massey University
David Carradine	BRANZ
Gabriele Chiaro	University of Canterbury
Charles Clifton	University of Auckland
Mary Anne Clive	GNS Science
Toni Collins	University of Canterbury
Seosamh Costello	University of Auckland
Nicholas Cradock-Henry	Lincoln University
Kaley Crawford-Flett	University of Canterbury
Kim de Graaf	University of Waikato
Chris de la Torre	University of Canterbury
Enrique Del Ray Castillo	University of Auckland
David Dempsey	University of Canterbury
Rajesh Dhakal	University of Canterbury
Ken Elwood	University of Auckland
Clark Fenton	University of Canterbury
Olga Filippova	University of Auckland
Joanna Fountain	Lincoln University
Matt Gerstenberger	GNS Science
Lesley Gray	University of Otago / Massey University
Emily Harvey	Market Economics Research
Ashkan Hashemi	University of Auckland
Tracy Hatton	Resilient Organisations

Lucas Hogan	University of Auckland
Nicolas Horspool	GNS Science
Andy Howell	GNS Science
Emma Hudson-Doyle	Massey University
Matthew Hughes	University of Canterbury
Anne Hulsey	University of Auckland
Robert Langridge	GNS Science
Chin-Long Lee	University of Canterbury
Robin Lee	University of Canterbury
Cécile L'Hermitte	University of Waikato
Minghao Li	University of Canterbury
Rebecca Lilley	University of Otago
Angela Liu	BRANZ
Tom Logan	University of Canterbury
Giuseppe Loporcaro	University of Canterbury
Quincy Ma	University of Auckland
Gregory MacRae	University of Canterbury
Sanna Malinen	University of Canterbury
Annick Masselot	University of Canterbury
Chris Massey	GNS Science
John McClure	Victoria University of Wellington
Samuel McColl	GNS Science
Nicola McDonald	Market Economics Research
Christopher McGann	University of Canterbury
Mark Milke	University of Canterbury
Paul Millar	University of Canterbury
Maxim Millen	University of Canterbury
Alessandro Palermo	University of Canterbury
Raj Prasanna	Massey University
Pierre Quenneville	University of Auckland
Shahab Ramhormozian	Auckland University of Technology (AUT)
Sean Rees	University of Canterbury
Thomas Robinson	University of Canterbury
Krishanu Roy	University of Waikato
Vinod Sadashiva	Massey University
Allan Scott	University of Canterbury
Max Stephens	University of Auckland
Carol Stewart	Massey University
Mark Stirling	University of Otago
Kristin Stock	Massey University
Andrew Stolte	University of Auckland
Mark Stringer	University of Canterbury
Charlotte Toma	University of Auckland
SR Uma	GNS Science
Priya Vishnu	Massey University
Kevin Wang	University of Auckland
Colin Whittaker	University of Auckland
Thomas Wilson	University of Canterbury
Fei Ying	Massey University
Pouyan Zarnani	Victoria University of Wellington
Conrad Zorn	University of Auckland

Industry Affiliates

Sarah Barrett	Beca
Derek Baxter	Wellington City Council
Jeff Bayless	AECOM
Nicholas Brooke	Compusoft Engineering
Dave Brunsdon	Kestrel Group
Des Bull	Holmes Consulting
Nigel Colenso	ABI Piers
Patrick Cummuskey	Auckland Council
Michael Drayton	Risk Management Solutions
Paul Drummond	CSI Limited
Roger Fairclough	Neo Leaf Global
Helen Ferner	NZSEE
Jeff Fraser	Golder Associates
Reza Jafarzadeh	Auckland Council
Jared Keen	Beca
Ajay Makhija	NEMA
Gareth Morris	Holmes Consulting
Stuart Oliver	Holmes Consulting
Aasha Pancha	Aurecon
Didier Pettinga	Holmes Consulting
Dario Pietra	Holmes Consulting
Andrew Renton	Transpower
Romy Ridl	KiwiRail
Wendy Saunders	Toka Tū Ake EQC
Andreas Skarlatoudis	AECOM
Paul Somerville	AECOM
Erin Todd	Golder Associates / WSP
Sjoerd Van Ballegooy	Tonkin + Taylor
Rick Wentz	Wentz Pacific
Stuart Woods	Waka Kotahi

Postdoctoral Fellows

In addition to the postdoctoral fellows listed below, there are a number of additional postdoctoral fellows that are part of the QuakeCoRE Community but funded with aligned funding.

Chanthujan Chandrakumar	Massey University
Tom Francis	University of Canterbury
Marion Tan	Massey University
Jeremy Treadwell	University of Auckland
Lauren Vinnell	Massey University

Students

Prestige Scholarship Recipients

Our Prestige Scholarship Recipients have been awarded Te Hiranga Rū QuakeCoRE Scholarships as outstanding students to support PhD research under the supervision of a QuakeCoRE Investigator.

Brandy Alger	University of Canterbury
Matthew Luani	Massey University

Students

In addition to the students listed below that received direct support towards their postgraduate studies, there are a number of students engaged with our research programme that are funded with aligned funding.

Yousef Abdeljawad	Victoria University of Wellington
Annecy Bal	University of Auckland
Vishvendra Bhanu	University of Canterbury
Angela Campbell	Victoria University of Wellington
Michael Dupuis	University of Canterbury
Akram Fatourehchishabestari	University of Auckland
Tom Francis	University of Canterbury
Rosa Gonzalez	University of Auckland
Kieran Haymes	University of Canterbury
Nicholas Horspool	University of Auckland
Samuel Julian	University of Auckland
Charles Kerby	University of Canterbury
Kaea Kerkin	University of Auckland
Anish Khadka	University of Auckland
Felipe Kuncar Garcia	University of Canterbury
Anna-Marei Kurei	University of Auckland
Charles Li	University of Auckland
Xin Liu	University of Auckland
Pouya Lotfi Rad	University of Auckland
Bethany Mayer	University of Waikato
Catalina Miranda	University of Auckland
Richard Mowll	Massey University
Sunil Nataraj	University of Auckland
Sarah Neill	University of Canterbury
Sally Nkrumah	University of Auckland
Marie Claire Pascua	University of Auckland
Liam Pledger	University of Canterbury
Macey Polwart	University of Canterbury
Yuping Qin	University of Waikato
Kiran Rangwani	University of Canterbury
Melanie Roundill	Victoria University of Wellington
Seyedamirhossein Shariati	University of Waikato
Julia Sit	University of Auckland
Vinu Sivakumar	University of Auckland
Tomomi Suzuki	University of Auckland
Ayushi Tiwari	University of Canterbury
Ren-Jie Tsai	University of Auckland
Linxuan Wang	University of Canterbury
Joshua Wight	University of Canterbury
Zhenduo Yan	University of Auckland
Majid Zakerinia	University of Auckland
Shen Zhan	University of Auckland

Other staff

Research Technicians

In addition to the Research Technicians listed below, there are a number of additional related roles that are supported with aligned funding.

Olivia Blyth
Lucy Kaiser
Yuan Liu
Yaél Philander
Kelvin Tapuke

Support Staff

Ruth Hartshorn
Brandy Alger
Vicki Smith
Rosemary Walton

Partners

University of Canterbury (Host)
Auckland University of Technology (AUT)
BRANZ
GNS Science
Lincoln University
Market Economics Research
Massey University
Resilient Organisations
University of Auckland
University of Otago
University of Waikato
Victoria University of Wellington

Affiliate Organisations

Building Research Institute (BRI)	Tsukuba, Japan
Copenhagen Center for Disaster Research (COPE)	Copenhagen, Denmark
DesignSafe	Austin, USA
EPICentre	London, UK
EU Centre	Pavia, Italy
Future Resilient Systems (FRS)	Singapore
Geotechnical Extreme Events Reconnaissance Association (GEER)	Atlanta, USA
International Joint Laboratory of Earthquake Engineering (ILEE)	Shanghai, China
Korea Institute of Science and Technology Information (KISTI)	Daegu, Korea
National Center for Research on Earthquake Engineering (NCREE)	Taipei, Taiwan
National Hazards Center (NHC)	Boulder, USA
National Hazards Engineering Research Infrastructure (NHERI) @UTexas	Austin, USA
National Hazards Engineering Research Infrastructure (NHERI) SimCenter	Berkeley, USA
Pacific Earthquake Engineering Research Center (PEER)	Berkeley, USA
Research Center for Integrated Disaster Risk Management (CIGIDEN)	Santiago, Chile
Southern California Earthquake Center (SCEC)	Los Angeles, USA
Smart Structures Lab, Swinburne University of Technology	Melbourne, Australia

Publications

91
Direct Peer-reviewed Outputs

103
Annual Meeting Posters

Journal Publications (Direct Peer-reviewed)

Anderson, M., Kiddle, D., & **Logan, T.** (2022). The underestimated role of the transportation network: Improving disaster & community resilience. *Transportation Research Part D: Transport and Environment,* **106**, 103218

Asadi, M., **Orense, R.**, Asadi, M., & Pender, M. (2022). A unified approach to link small-strain shear modulus and liquefaction resistance of pumiceous sand. *Soils and Foundations,* **62**, 101098

Ball, R., **Hudson-Doyle, E.**, Nuth, M., **Hopkins, W.**, Brunsdon, D., & **Brown, C.** (2022). Behavioural science applied to risk-based decision processes: A case study for earthquake prone buildings in New Zealand. *Civil Engineering and Environmental Systems,* **39**, 144 – 164

Becker, J., Vinnell, L., McBride, S., Nakayachi, K., **Hudson-Doyle, E.**, Potter, S., & Bostrom, A. (2022). The effects of earthquake experience on intentions to respond to earthquake early warnings. *Frontiers in Communication,* **7**, 857004

Bhatta, J., **Dhakal, R.**, & **Sullivan, T.** (2022). Seismic performance of a rocking precast concrete cladding panel system under lateral cyclic displacement demands. *Journal of Earthquake Engineering,* **27(4)**, 929 – 958

Bhatta, J., **Dhakal, R.**, **Sullivan, T.**, & Lanyon, M. (2022). Low-damage rocking precast concrete cladding panels: Design approach and experimental validation. *Journal of Earthquake Engineering,* **26**, 4387 – 4420

Bolomope, M., Amidu, A., Levy, D., & **Filippova, O.** (2022). Organizational isomorphism and property investment decision-making amidst disruptions: Evidence from listed property trusts in New Zealand. *International Journal of Strategic Property Management,* **26**, 230 – 240

Bradley, B., Cubrinovski, M., & Wentz, F. (2022). Probabilistic seismic hazard analysis of peak ground acceleration for major regional New Zealand locations. *Bulletin of the New Zealand Society for Earthquake Engineering,* **55**, 15 – 24

Brown, C., Seville, E., Horsfall, S., Bugler, G., Brunsdon, D., & Hare, J. (2022). Seismic repair and retrofit prioritization framework. *Earthquake Spectra,* **38**, 2886 – 2900

Chang, S., **Brown, C.**, Handmer, J., Helgeson, J., Kajitani, Y., Keating, A., **Noy, I.**, Watson, M., Derakhshan, S., Kim, J., & Roa-Henriquez, A. (2022). Business recovery from disasters: Lessons from natural hazards and the COVID-19 pandemic. *International Journal of Disaster Risk Reduction,* **80**, 103191

Chigullapally, P., **Hogan, L.**, **Wotherspoon, L.**, **Stephens, M.**, & Pender, M. (2022). Experimental and numerical analysis of the lateral response of full-scale bridge piers. *Bulletin of the New Zealand Society for Earthquake Engineering,* **55**, 95 – 111

Cubrinovski, M., **Bradley, B.**, Wentz, F., & Balachandra, A. (2022). Re-evaluation of New Zealand seismic hazard for geotechnical assessment and design. *Bulletin of the New Zealand Society for Earthquake Engineering,* **55**, 1 – 14

De Francesco, G., & **Sullivan, T.** (2022). Formulation of localized damping models for large displacement analysis of single-degree-of-freedom inelastic systems. *Journal of Earthquake Engineering,* **26**, 4235 – 4258

De Francesco, G., & **Sullivan, T.** (2022). P-Delta effects on short-period systems subjected to earthquake excitation. *Engineering Structures,* **254**, 113642

De Francesco, G., **Sullivan, T.**, & Nievas, C. (2022). Highlighting the need for multiple loading protocols in bi-directional testing. *Bulletin of the New Zealand Society for Earthquake Engineering,* **55**, 80 – 94

de la Torre, C., Bradley, B., & **McGann, C.** (2022). 2D geotechnical site-response analysis including soil heterogeneity and wave scattering. *Earthquake Spectra,* **38**, 1124 – 1147

de la Torre, C., Bradley, B., Stewart, J., & **McGann, C.** (2022). Can modeling soil heterogeneity in 2D site response analyses improve predictions at vertical array sites? *Earthquake Spectra,* **38**, 2451 – 2478

Delano, J., **Howell, A.**, **Stahl, T.**, & Clark, K. (2022). 3D coseismic surface displacements from historical aerial photographs of the 1987 Edgecumbe Earthquake, New Zealand. *Journal of Geophysical Research,* **127(11)**, e2022JB024059

Dhakal, M., **Scott, A.**, **Dhakal, R.**, **Sullivan, T.**, & Clucas, D. (2022). Performance of MgO-Mk based M-S-H concrete column reinforced with steel and BFRP bars under cyclic loads. *Structures,* **46**, 1764 – 1780

Gonzalez, R., **Stephens, M.**, **Toma, C.**, & Dowdell, D. (2022). The estimated carbon cost of concrete building demolitions following the Canterbury Earthquake Sequence. *Earthquake Spectra,* **38**, 1615 – 1635

Gray, L., **Becker, J.**, MacDonald, C., & **Johnston, D.** (2022). Sizing up disaster risk reduction: A qualitative study of the voices of big bodied people in Aotearoa New Zealand. *International Journal of Disaster Risk Reduction,* **74**, 102922

Gray, L., MacDonald, C., **Becker, J.**, & **Johnston, D.** (2022). A qualitative study of emergency management considerations for big-bodied people in Aotearoa New Zealand. *International Journal of Disaster Risk Reduction,* **67**, 102646

Gu, A., Zhou, Y., **Henry, R.**, Lu, Y., & **Rodgers, G.** (2022). Simulation of shake-table test for a two-story low-damage concrete wall building. *Structural Control and Health Monitoring,* **29**, e3038

Hasanali, M., Roy, K., Mojtabaei, S., Hajirasouliha, I., **Clifton, G.**, & Lim, J. (2022). A critical review of cold-formed steel seismic resistant systems: Recent developments, challenges and future directions. *Thin-Walled Structures,* **180**, 109953

Lee, R., **Bradley, B.**, Stafford, P., Graves, R., & Rodriguez-Marek, A. (2022). Hybrid broadband ground-motion simulation validation of small magnitude active shallow crustal earthquakes in New Zealand. *Earthquake Spectra,* **38**, 2548 – 2579

Liu, X., & **Nair, N.** (2022). Enhanced morlet wavelet-based two-point FIR for phasor estimation. *IEEE Transactions on Smart Grid,* **13**, 4704 – 4715

Lu, Y., **Henry, R.**, Zhou, Y., **Rodgers, G.**, Yang, Q., & Gu, A. (2022). Data set for a shake-table test of a 2-story low-damage concrete wall building. *Journal of Structural Engineering,* **148**, 4722002

Mowll, R., **Becker, J.**, **Wotherspoon, L.**, **Stewart, C.**, **Johnston, D.**, Neeley, D., Rovins, J., & Ripley, S. (2022). Infrastructure planning emergency levels of service for the Wellington region, Aotearoa New Zealand – A preliminary framework. *International Journal of Disaster Risk Reduction,* **72**, 102843

Mulligan, J., **Sullivan, T.**, & **Dhakal, R.** (2022). Experimental seismic performance of partly-sliding partition walls. *Journal of Earthquake Engineering,* **26**, 1630 – 1655

Nataraj, S., **Hogan, L.**, **Scott, A.**, & **Ingham, J.** (2022). Simplified mechanics-based approach for the seismic assessment of corroded reinforced concrete structures. *Journal of Structural Engineering,* **148**, 4021296

Orumiyehei, A., & **Sullivan, T.** (2022). Quantifying the likelihood of exceeding a limit state via the displacement-based assessment approach. *Journal of Earthquake Engineering,* **26**, 4346 – 4364

Prasanna, R., Chandrakumar, C., Nandana, R., Holden, C., Punchihewa, A., **Becker, J.**, Jeong, S., Liyanage, N., Ravishan, D., Sampath, R., & Tan, M. (2022). "Saving Precious Seconds"—A novel approach to implementing a low-cost earthquake early warning system with node-level detection and alert generation. *Informatics,* **9**, 25

Quinn, P., Gibbs, L., **Blake, D.**, Campbell, E., **Johnston, D.**, Richardson, J., & Coghlan, A. (2022). Recovery Capitals: A collaborative approach to post-disaster guidance. *Australian Journal of Emergency Management,* **36**, 52 – 61

Rashid, M., **Dhakal, R.**, **Sullivan, T.**, & Yeow, T. (2022). Seismic performance characterization of fire sprinkler piping systems through shake table testing. *Bulletin of the New Zealand Society for Earthquake Engineering,* **55**, 167 – 182

Rodgers, G., Chase, J., Roland, T., **MacRae, G.**, & Zhou, C. (2022). Nonlinear semi-active/passive retrofit design evaluation using incremental dynamic analysis. *Earthquake and Structures,* **22**, 109 – 120

Rushton, A., Phibbs, S., **Kenney, C.**, & Anderson, C. (2022). 'She'll be right': The place of gendered emotions in disasters. *Gender, Place and Culture,* **29**, 793 – 815

Rushton, A., Phibbs, S., **Kenney, C.**, & Anderson, C. (2022). 'I wouldn't trade this country of ours for anything': Place, identity and men's stories of the 2016 M7.8 Kaikōura/Waiau Earthquake. *Social and Cultural Geography,* **23**, 1155 – 1173

Ryder, R., **Wotherspoon, L.**, & **Stolte, A.** (2022). Shear wave velocities of prominent geologic formations in the Nelson-Tasman region. *Bulletin of the New Zealand Society for Earthquake Engineering,* **55**, 43 – 57

Sarkis, A., Büker, F., **Sullivan, T.**, **Elwood, K.**, Brunesi, E., & **Hogan, L.** (2022). Aspects affecting the nonlinear behavior of precast prestressed hollow-core units failing in shear. *Structural Concrete,* **23**, 3021 – 3038

Sarkis, A., **Sullivan, T.**, Brunesi, E., & Nascimbene, R. (2022). Critical modelling criteria for precast pre-stressed hollow-core slabs. *Journal of Building Engineering,* **54**, 104545

Shrestha, S., & **Pujol, S.** (2022). Drift capacity of reinforced concrete columns. *ACI Structural Journal,* **120**, 215 – 224

Shrestha, S., Carrillo, J., Sezen, H., & **Pujol, S.** (2022). Shear strength of shear-controlled columns under cyclic loading. *ACI Structural Journal,* **119**, 129 – 140

Shrestha, S., **Orchiston, C.**, **Elwood, K.**, **Johnston, D.**, **Becker, J.**, & Tomassi, I. (2022). Understanding the wider social and economic context of post-earthquake cordons: A comparative case study between Christchurch, Aotearoa (New Zealand) and L'Aquila, Italy. *Earthquake Spectra,* **38**, 2731 – 2753

Singeisen, C., **Massey, C.**, Wolter, A., Kellett, R., Bloom, C., **Stahl, T.**, Gasston, C., & Jones, K. (2022). Mechanisms of rock slope failures triggered by the 2016 Mw 7.8 Kaikōura Earthquake and implications for landslide susceptibility. *Geomorphology,* **415**, 108386

Stolte, A., **Wotherspoon, L.**, Cox, B., Wood, C., Jeong, S., & Munro, J. (2022). The influence of multiple impedance contrasts on mHVSR site period estimates in the Canterbury plains of New Zealand and implications for site classification. *Earthquake Spectra,* **39(1)**, 288 – 309

Sullivan-Taylor, B., Gunnell, S., **Becker, J.**, & **Johnston, D.** (2022). Improving resilience: A longitudinal analysis of land-use policy and planning for earthquakes in Aotearoa New Zealand, 2000-16. *The Australian Journal of Emergency Management,* **37**, 45 – 55

Ta, Q., Jinjarak, Y., & **Noy, I.** (2022). How do shocks affect international reserves? A quasi-experiment of earthquakes. *Open Economies Review,* **33**, 945 – 971

Tan, M., **Becker, J.**, **Stock, K.**, **Prasanna, R.**, **Brown, A.**, **Kenney, C.**, Cui, A., & Lambie, E. (2022). Understanding the social aspects of earthquake early warning: A literature review. *Frontiers in Communication,* **7**, 939242

Tong, Q., **Filippova, O.**, & **Ingham, J.** (2022). Effectiveness of unreinforced masonry seismic retrofit programmes: Review of policies in New Zealand and the United States. *International Journal of Disaster Risk Reduction,* **76**, 103008

Vinnell, L., **Hudson-Doyle, E.**, Inch, P., Tan, M., **Becker, J.**, & **Johnston, D.** (2022). Evacuation behavior and information needs of Wellington, Aotearoa New Zealand residents following the 5 March 2021 Mw 7.3 East Cape Earthquake. *Seismological Research Letters,* **93**, 1452 – 1463

Vinnell, L., Inch, P., **Johnston, D.**, & **Horspool, N.** (2022). Behavioral responses to earthquake shaking: Video footage analysis of the 2016 Kaikōura Earthquake in Wellington, Aotearoa New Zealand. *Earthquake Spectra,* **38**, 1636 – 1660

Vishnupriya, V., **Rodgers, G.**, & Chase, J. (2022). Nonlinear finite-element modeling of HF2V lead extrusion damping devices: Generic design tool. *Journal of Structural Engineering,* **148**, 4021227

Vittal, V., **Nair, N.**, & Rahmatian, F. (2022). Smart city energy technology in the face of emergency situations: Electric supply, electric transportation, and communication. *IEEE Power and Energy Magazine,* **20**, 16 – 25

Walsh, E., **Stahl, T.**, **Howell, A.,** & **Robinson, T.** (2022). Two-dimensional empirical rupture simulation: Examples and applications to seismic hazard for the Kaikōura region, New Zealand. *Seismological Research Letters,* **94(2A)**, 852 – 870

Xie, R., **Rodgers, G.**, & **Sullivan, T.** (2022). Effect of damper sub-system stiffness on the response of a single degree of freedom system equipped with a viscous damper. *Journal of Earthquake Engineering,* **26**, 5907 – 5926

Yang, T., Qiao, T., Tobber, L., & **Rodgers, G.** (2022). Seismic performance of controlled outrigger rocking wall system with different energy dissipation devices. *Soil Dynamics and Earthquake Engineering,* **155**, 107179

Published Conference Proceedings (Direct Peer-Reviewed)

Ahmed, H., **Vishnupriya, V., Rodgers,** G., & Wilkinson, S. (2022) Numerical/computational study of the effect of braced stiffness equipped with nonlinear viscous dampers on the MDOF system. *7th New Zealand Built Environment Research Symposium*.

Bal A., Evangelio C., **Wotherspoon L.**, **Hogan L.**, & **Stephens M. (**2022) Fragility Models for Wall-type Pier Bridges in New Zealand. *12th National Conference on Earthquake Engineering, NCEE 2022.*

Bradley, B. (2022) Prediction of earthquake-induced ground motions using simulation methods and their validation against observations. *20th International Conference on Soil Mechanics and Geotechnical Engineering.*

Chandrakumar, C., **Prasanna, R.**, **Stephens, M.**, Tan, M., Holden, C., Punchihewa, A., & Ravishan, D. (2022) Algorithms for detecting P-waves and earthquake magnitude estimation: Initial literature review findings. *Proceedings of the 2nd ISCRAM Asia Pacific Conference.*

Clement, R., **Dhakal, R.**, Tripathi, M., De Francesco, G., Rashid, M., & **Sullivan, T. (**2022) Quasi-static cyclic testing of a drift-sensitive sub-assembly of non-structural elements with low-damage characteristics. *ATC-SPONSE 5th International Workshop on the Seismic Performance of Non-Structural Elements.*

Forcellini D., **Chiaro G.**, **Palermo A.** & Banasiak L. (2022) Numerical evaluation of the seismic performance of GSI foundation systems for buildings using gravel-rubber mixtures. *Lecture Notes in Civil Engineering: Proceedings of the 17th Symposium of Earthquake Engineering.*

Gu, A., **Rodgers, G.**, Yang, Q., **Henry, R.**, Lu, Y., & Zhou, Y. (2022) Study on floor-slab out-of-plane effect of a 2-storey low-damage concrete wall building. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Haymes, K., **Sullivan, T.**, Chandramohan, R., & Weibe, L. (2022) Prediction of demands on non-structural components in base-isolated structures. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Haymes, K., **Sullivan, T.**, **Chandramohan, R.**, & Wiebe, L. (2022) A practice-oriented floor response spectrum prediction method for seismic design of non-structural elements. *ATC-SPONSE 5th International Workshop on the Seismic Performance of Non-Structural Elements.*

Hoete A., & Jorgensen A. (2022) The Architecture of Interaction. *2022 Australiasian Society for Historical Archaelology.*

Hoete A., McKay B. (2022) Te Whare Rangitupu: The scaffolded house. *Ngā Pūtahitanga / Crossings: A Joint Conference of SAHANZ and the Australasian UHPH Group.*

Hong, B., Chandrakumar, C., Ravishan, D., & **Prasanna, R. (**2022) A peer-to-peer communication method for distributed earthquake early warning networks: Preliminary findings. *Proceedings of the 2nd ISCRAM Asia Pacific Conference.*

Hutchinson, J., **Bradley, B.**, **Lee, R.,** Schill, C., Dupuis, M., Motha, J., van Houtte, C., Kaiser, A., Manea, E., & **Wotherspoon, L. (**2022) Insights from the 2021 New Zealand strong ground motion database. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Johnston, D., **Becker, J.**, Vinnell, L., Kaiser, L., Tapuke, K., **Orchiston, C.**, Akther, M., **Stirling, M.**, Stewart, J., & Lake-Hammond, A. (2022) The shaky South (or not): Towards improving communities understanding of earthquake risk in Otago and Southland. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Kaiser, L., Tapuke, K., **Johnston, D.**, & **Becker, J.** (2022) Enhancing earthquake and tsunami preparedness and response in Kura Kaupapa Māori/ Schools Aotearoa New Zealand: Learnings from the 5 March 2021 East Cape Earthquake Sequence. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Kenney, C. (2022) Indigenous peoples and inclusivity: Considerations for disaster risk reduction science and technology. *2022 UNDRR Asia Pacific Science and Technology Conference for Disaster Risk Reduction.*

Lee, R., **Bradley, B.**, Hutchinson, J., & Manea, E. (2022) Interim results from the empirical ground motion model evaluation for the NZ National Seismic Hazard Model update. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Munoz, G., **Henry, R.**, & **Elwood, K.** (2022) Experimental response of earthquake damaged reinforced concrete walls. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Orense, R., Ha, J., Shetty, A., & Asadi, M. (2022) Shear work and liquefaction resistance of crushable pumice sand. *4th International Conference on Performance-based Design in Earthquake Geotechnical Engineering.*

Pokhrel. A., **Chiaro G.**, Cubrinovski M. & Takashi K. (2022) Liquefaction potential of sand-gravel mixtures: experimental observations. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Rangwani, K., **MacRae, G.**, **Rodgers, G.**, & Soleimankhani, H. (2022) Slab effects on rocking frame performance. *Lecture Notes in Civil Engineering: Proceedings of the 10th International Conference on Behaviour of Steel Structures in Seismic Areas.*

Rashid, M., **Dhakal, R.**, **Sullivan, T.**, & Yeow, T. (2022) Seismic demand on sprinkler piping systems: Findings from a shake table testing program and relevance to NZ standards. *ATC-SPONSE 5th International Workshop on the Seismic Performance of Non-Structural Elements.*

Stirling, M., Williams, J., & Griffin, J. (2022) Seismic source characterisation in Southern New Zealand, an update. *Geoscience Society of New Zealand Annual Conference.*

Stolte A., **Wotherspoon L.**, & Girgis, P. (2022) Dynamic site characterisation of the Hawke's Bay sedimentary basin using H/V and surface wave methods. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Stringer, M. (2022) Response of pumice-rich soils to cyclic loading. *4th International Conference on Performance-based Design in Earthquake Geotechnical Engineering.*

Vinnell, L., Inch, P., **Johnston, D.**, & **Horspool, N.** (2022) Social influences on behavioural response to earthquake shaking. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

Vishnupriya, V., **Rodgers, G.**, & Chase, J. (2022) Lead extrusion damper force modelling for seismic protection application in buildings using finite element modelling. *7th New Zealand Built Environment Research Symposium.*

Vishnupriya, V., **Rodgers, G.**, & Chase, J. (2022) A generalizable nonlinear finite element model to predict hysteretic response forces of lead-extrusion damping devices. *12th National Conference on Earthquake Engineering, NCEE 2022.*

Williamson, M., John, L., & **Sullivan, T.** (2022) Assessing the impact of acceleration-sensitive components on the seismic losses of multi-storey office buildings. *New Zealand Society for Earthquake Engineering 2022 Annual Conference.*

QuakeCoRE Annual Meeting Posters

103 posters were presented at the Te Hiranga Rū QuakeCoRE Annual Meeting in Ahuriri Napier from 30 August – 1 September, 2022

Abeling, S., Hulsey, A., **Brown, C.**, **Elwood, K.**, Ferner, H., & Cowan H.
Resilient Buildings Project Workshop: Integrating societal expectations into the seismic design of buildings

Ferner, H., Abeling, S., Cowan, H., & **Brown, C.**
Resilient Buildings Project: Using Societal Expectations to Inform Tolerable Impacts for the Seismic Performance of New Buildings

Akther, M, **Orchiston, C.**, & **Johnston, D.**
What's in a name? Policy implications for developing earthquake resilience in low seismic hazard zones of New Zealand

Alizadeh, F., **Ramhormozian, S.**, & **Clifton, C.**
Finite Element Modelling (FEM) of the Asymmetric Friction Connection (AFC)

Amos, A., **Fenton, C.**, Walker, J., **Rodgers, G.**, & **Logan, T.**
Fibre Optic Cable Network Vulnerability to Shallow Geohazards

Anderson, M., & **Logan, T.**
Utilising risk curves to support adaptive decision-making

Archie, S., Fleming, J., Peer, R., & **Logan, T.**
Intelligent Retreat: Guiding relocation of residential communities given multiple planning objectives

Assadi, S., **Hashemi, A.**, & **Quenneville, P.**
Low Damage Wall to Floor Connections for Seismic Resilient Timber Structures

Avendano, B., Lukosch, H., & **Milke, M.**
Playing with Uncertainty: Facilitating Community-Based Resilience

Bae, S., Jeong, S., Kim, J., & Kim, K.
Broadband Physics-based strong ground motion simulations for the southern Korean Peninsula

Bal, A., Evangelio, C., **Wotherspoon, L.**, **Hogan, L.**, & **Stephens, M.**
Are Our Bridges Fragile? Investigating the Seismic Performance of the State Highway Network

Bloom, C., Singeisen, C., **Stahl, T.**, **Massey, C.**, & **Howell, A.**
Strong ground motion and landslides from the 2016 Mw 7.8 Kaikōura Earthquake

Boston, M., Dunlap, E., & Owen, M.
Māori Resilience: Deriving resilience frameworks from Māori historical and modern practices

Brunner, L., & **Logan, T.**
Natural Hazards and Their Cascading Impacts on Our Interdependent Infrastructure

Buck, N., & Clarke, G.
Structural Resilience and Functionality Implications of Designing to Various International Standards

Büker, F., **Elwood, K.**, **Hogan, L.**, Brooke, N., Bull, D., & **Sullivan, T.**
Experimental Validation of Novel Precast Hollow-core Floor Retrofits

Carradine, D., & **Liu, A.**
Full-Scale Testing of Light Timber Frame Walls and Floor-Ceiling Diaphragm System

Chandrakumar, C., **Prasanna, R.**, **Stephens, M.**, Holden, C., Punchihewa, A., **Becker, J.**, Jeong, S., & Tan, M.
An Ecosystem of Low-cost Sensors toward Earthquake Early Warning: - An Earthquake Early Warning System (EEWS) with multi-sensor capability

Chandramohan, R., Pledger, L., & **Pujol, S.**
Can we mitigate seismic loss by designing stiffer buildings?

Chaneva, J., Kluger, M., Melchert, R., Moon, V., Lowe, D., & **Orense, R.**
Cyclic undrained behaviour and liquefaction resistance of a lacustrine pumiceous sandy silt, North Island, New Zealand

Cui, A., Tan, M., **Prasanna, R.**, Syed, Y., Hong, B., & Viggers, Z.
CRISiSLab Challenge – hands-on learning with Raspberry Shake seismometers

Das, M., **Becker, J.**, & **Hudson-Doyle, E.**
Communication, Community Action, and Disaster Resilience - Understanding the role of communication in supporting community action for disaster resilience

Del Rey Castillo, E., **Hogan, L.**, **Stephens, M.**, & Allen, T.
Strengthening concrete diaphragms with FRP

Dhakal, R., & Cubrinovski, M.
Applicability of Simplified CPT-Based Liquefaction Assessment to CentrePort Gravels

Dhungana, A., **Doyle, E.**, **Prasanna, R.**, **McDonald, G.**, & Paton, D.
Model Uncertainty - Where and What should we know in Hazard/Risk Modelling

Dong, C., **Sullivan, T.**, & Pettinga, D.
Risk-Oriented Design of Base-Isolated Buildings in New Zealand

Faulkner, H.
Governing Disasters in Aotearoa New Zealand: An Auckland Volcanic Field Case Study

Fenton, C.
Fault Rupture Hazard Zonation: Options for Best Practice in New Zealand

Filippova, O., Tong, Q., & Cheung, W.
Lost in translation: Investigating the interplay between seismic policy language and commercial property listings

Francis, S., **Stock, K.**, **Prasanna, R.**, Jones, C., **Hudson-Doyle, E.**, Aflaki, N., Medagoda, N., Mowll, R., Tregoweth, A., Treadgold, G., & Waterreus, A.
QuakeText: Mapping Earthquake Impacts from Text

Goltz, J.
Operational Earthquake Forecasting for the Nankai Trough in Japan: Local Government Planning for Receipt of a Warning from the JMA

Gonzalez, R., **Stephens, M.**, **Toma, C.**, & Dowdell, D.
Carbon Risk - A new green seismic performance metric

Gu, A., **Rodgers, G.**, **Henry, R.**, Lu, Y., Yang, Q., & Zhou, Y.
Simulation of a 2-storey low-damage concrete wall building considering system level interactions

Harris, L., **Robinson, T.**, & **Wilson, T.**
Agent-based modelling of evacuation scenarios for a landslide-generated tsunami in Milford Sound.

Haymes, K.
Floor Response Spectra in Buildings with Low Damage Technologies

Holden, C.
Engaging with End-users Towards an Earthquake Early Warning System for New Zealand

Horspool, N., Goded, T., Kaiser, A., Chadwick, M., Charlton, D., Houltham, J., Groom, J., & Moratalla, J.
GeoNet's Shaking Layer Tool: Automatic generation of maps of near-real time ground shaking for post-earthquake response

Johnson, L.
Interventions to improve earthquake resilience: Surveying disaster researchers in Aotearoa New Zealand

Johnston, D., **Horspool, N.**, Vinnell, L., **Hogan, L.**, & **Stephens, M.**
Meet EDDIE – QuakeCoRE's new earthquake test dummy

Tapuke, K., **Johnston, D.**, Kaiser, L., & **Becker, J.**
Enhancing earthquake and tsunami preparedness and response in Kura Kaupapa Māori/Schools Aotearoa New Zealand

Kerby, C.
Staggered Lap Splices in Reinforced Concrete Structural Walls

Kim, J., & Jeong, S.
Characterization of dynamic site properties in the Gimhae Plains using the Microtremor Array Method and the Horizontal-to-Vertical Spectral Ratio method

Kuncar, F., **de la Torre, C., Bradley, B.**, & **Lee, R.**
Evaluating the performance of 1D site-response analysis in physics-based earthquake ground-motion simulations: Insights from small-magnitude events

Kuwabara, R.
Effect of Cyclic Demands on Residual Capacity of Reinforcing Steel Bars

Lacrosse, V., McDougall, N., Saunders, W., van Ballegooy, S., & Bird, E.
Loss Modelling of Lower Hutt to Inform Future Growth Planning

Li, L., **Chang-Richards, A.**, **Boston, M.**, & **Elwood, K.**
Analysis of quantitative methods for assessing functional recovery in post-earthquake

Li, Z.
Seismic strengthening of RC walls using FRP to prevent axial failure

Logan, T.
A holistic conceptualisation of risk and resilience

London, W., & **L'Hermitte, C.**
Maintaining the continuity of cruise ship supply chains in the aftermath of sudden disasters

Lotfi Rad, P., **Clifton, G.**, & Lim, J.
Seismic behaviour of cold-formed steel strap-braced stud walls as lateral force resisting systems for residential mid-rise buildings

MacKenzie, J.
Stories of Glenorchy – Community Engagement and Resilience in Adapting to Cascading Natural Hazards

Magill, C., **Horspool, N.**, Moratalla, J., Wang, X., Beale, T., Griffiths, N., Lin, S., Woods, R., Heron, D., Kelly, S., & Lukovic, B.
RiskScape® for multi-hazard multi-impact risk assessment – Napier case study

Mason, D., Brabhaharan, P., **Fenton, C.**, & **Massey, C.**
Performance of cut and fill slopes in the 2016 Kaikōura Earthquake

Mayer, B., **Boston, M.**, & **Chang-Richards, A.**
Post-disaster functionality requirements of building occupancies: A literature review

McCombe, G.
A Lot on Our Plates - East Coast LAB and AF8 Social Media campaign

McDougall, N., Lacrosse, V., van Ballegooy, S., & Bird, E.
Loss Modelling of Shaking and Liquefaction damage to NZ Residential Buildings — New Fragility Functions

McEwan, E., **Stahl, T., Howell, A., Langridge, R.**, & Wilson, M.
Modelling Fault-rupture Induced River Avulsions: A new method for examining coseismic river response to fault-surface displacement

McMecking, J., **Robinson, T.**, Wolter, A., & **Stahl, T.**
Modelling the Hazard and Risk of Landslide Dam Outburst Flooding on the West Coast, New Zealand

Miranda, C., **Toma, C.**, **Elwood, K.**, **Becker, J.**, **Johnston, D.**, & **Stephens, M.**
Building Typology of Wooden Houses

Morris, N., **Chandramohan, R., & McGann, C.**
Mitigating the occurrence of numerical non-convergence in nonlinear structural analysis

Motha, J., **Bradley, B.**, Paterson, J., **Lee, R.**, Tarbali, K., & Schill C.
Cybershake NZ v22.6: New Zealand simulation-based probabilistic seismic hazard analysis

Mowll, R.
Infrastructure planning emergency levels of service for the Wellington Region

Mueller, S., **Orchiston, C.**, & Bond, S.
Exploring Rural Communities' Resilience to Natural Hazards: A participatory disaster scenario simulation addressing secondary and cascading hazards

Naguit, M., Young, J., & Salichon, J.
GeoNet's Strong Motion Network: 21 Years of Data Products & Services

Nwadike, A., **Aigwi, E.**, & Wilkinson, S.
New Zealand Building consent activities in the COVID-19 pandemic era

Pascua, C., **Henry, R.**, & **Toma, C.**
Experimental tests on concrete wall-steel beam connections

Paterson, J., **Bradley, B.**, Wilson, P., **Lee, R.**, & Motha, J.
Effect of Hikurangi subduction interface geometry on simulated ground motion intensities

Polwart, M., & **Robinson, T.**
Risk from post-earthquake landslides: modelling potential remobilisation of coseismic landslides

Prasanna, R., Chandrakumar, C., Nandana, R., Holden, C., Punchihewa, A., **Becker, J.**, Jeong, S., Liyanage, N., Ravishan, D., Sampath, R., & Tan, M.
Novel Earthquake Early Warning Sensor Architecture Driven by Low-Cost Ground Motion Sensors

Prattley, L., Beaven, S., **Wilson, T.**, Leonard, G., & Williams, J.
Tsunami Evacuation Behaviour: A review of survey findings across Aotearoa New Zealand

Qin, Y., & **L'Hermitte, C.**
Identifying and mitigating post-disaster transport disruptions: a study of perishable food deliveries in New Zealand

Rahayani, R., & **Nair, N.**
GIS-AHP Analysis of Optimal Solar Site Locations based on Disaster Risk Assessment

Rangwani, K., **Rodgers, G.**, **MacRae, G.**, **Ramhormozian, S.**, **Clifton, C.**, & Yan, Z.
Frictional GripNGrab Component Test

Rincon Gil, J., **Pujol, S.**, & **Dhakal, R.**
Active Confinement of Reinforced Concrete Columns

Sadashiva, V., Wang, X., Lukovic, B., Lin, S., Heron, D., & Suppasri, A.
Demonstrating the effects of explicit inclusion of buildings in tsunami inundation modelling

Sauvage, E., Latif, F., & **Nair, N.**
Evaluating the seismic resilience of the fixed communication systems

Scheele, F., **Wilson, T.**, **Becker, J.**, **Horspool, N.**, & Campbell, M.
Estimating population displacement following natural hazard events

Shrestha, S., **Orchiston, C.**, **Elwood, K.**, **Becker, J.**, **Johnston, D.**, & Tomassi, I.
Post-Earthquake Cordons in Practice

Singeisen, C., **Massey, C.**, Wolter, A., Bloom, C., Kellett, R., Bruce, Z., & **Stahl, T.**
Fault zone contributions to the evolution of a landslide complex – insights from Half Moon Bay, Kaikōura

Sistla, S., Chandramohan, R., & **Sullivan, T.**
Benchmarking the seismic performance of a code compliant BRBF building

Sit, J.
Energy-based Liquefaction Assessment Method for Pumiceous Materials

Sivakumar, V., **Hogan, L.**, & **Henry, R.**
Seismic behaviour of low-rise precast wall to foundation connection

Smith, J., Beaven, S., **Wilson, T.**, & Leonard, G.
The 5th March 2021 Earthquake and Tsunami Response Survey: collaborative approaches to designing and implementing a national research project.

Stahl, T., Walsh, E., **Howell, A., & Robinson, T.**
Multi-fault earthquakes in an empirical rupture simulator

Stolte, A., **Wotherspoon, L.**, Jeong, S., & Munro, J.
The influence of multiple impedance contrasts on mHVSR site period estimates in the Canterbury Plains of New Zealand

Syed, Y., **Uma, S.**, & **Sadashiva, V.**
Identification of significant factors for the recovery of distributed infrastructure networks through knowledge elicitation processes

Tan, M., Vinnell, L., **Prasanna, R., & Becker, J.**
The public's initial insights on the Android Earthquake Alerts in Aotearoa New Zealand

Till, H., **Stephens, M.**, & **Toma, C.**
A Structural Approach to Tsunami Loading on Buildings

Tsai, R., **Henry, R.**, & **Elwood, K.**
System response of reinforced concrete coupled walls

Vercoe, H.
Natural Hazard Recognition & Vulnerability of Marae Infrastructure

Vinnell, L., Inch, P., **Johnston, D.**, & **Horspool, N.**
Social Influences on Behavioural Response to Earthquake Shaking

Vishnu, P., & **Rodgers, G.**
Low-cycle fatigue testing of sacrificial energy dissipating fuses to better understand residual capacity.

Walakulu Arachchige, R., Francois-Holden, C., Savage, M., & Andreae, P.
Testing Earthquake Early Warning Systems for Aotearoa New Zealand

Wang, K.
Realising interdisciplinary machine learning research in QuakeCoRE

Wight, J., **Logan, T.**, Mollenkopf, D., & **Brown, C.**
Improving Urban Food Supply Chain Resilience using Hybrid Agent-Based Modelling and Discrete-Event Simulations of Local Supply Chains

Wolter, A., Upton, P., **Uma, S.**, & Kaiser, A.
Site-City Interaction effect on seismic waves – preliminary 2D modelling in the Wellington CBD

Wotherspoon, L., Lin, A., & **Zorn, C.**
How has land movement from the 1931 Hawke's Bay earthquake affected regional exposure?

Yan, Z., Xie, J., Rangwani, K., **Ramhormozian, S.**, Xiang, P., Jia, L., **Quenneville, P.**, **Dhakal, R.**, **Clifton, C.**, **MacRae, G.**, & Zhao, X.
Three-storey Configurable Steel Framed Building Incorporating Friction Based Energy Dissipaters: Overview of Component Test Results

Ying, F., Mireku, S., & **Filippova, O.**
Building user expectations of repaired buildings and restoration timeframes

Zaidi, F., **Elwood, K.**, **Stephens, M.**, & **Horspool, N.**
Fatality Risk Calculation Tool to Facilitate Post-Assessment Decision Making

Zhan, S., **Chang-Richards, A.**, **Boston, M.**, & **Elwood, K.**
A critical review of measuring building functionality post-disaster

Zhou, H., **Wotherspoon, L.**, **Stolte, A.**, Hayden, C., & **McGann, C.**
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Zhou, H., **Wotherspoon, L.**, **Stolte, A.**, Hayden, C., & **McGann, C.**
Applicability of existing empirical CPT-Vs correlations for shallow Christchurch Holocene soil deposits