TC203 Earthquake Discoverer's Report

PREPARED BY:

RHIANNON ROBINSON (NEW ZEALAND GEOTECHNICAL SOCIETY - NZGS)

HTC contribution

TC203 Contribution Reviewed:

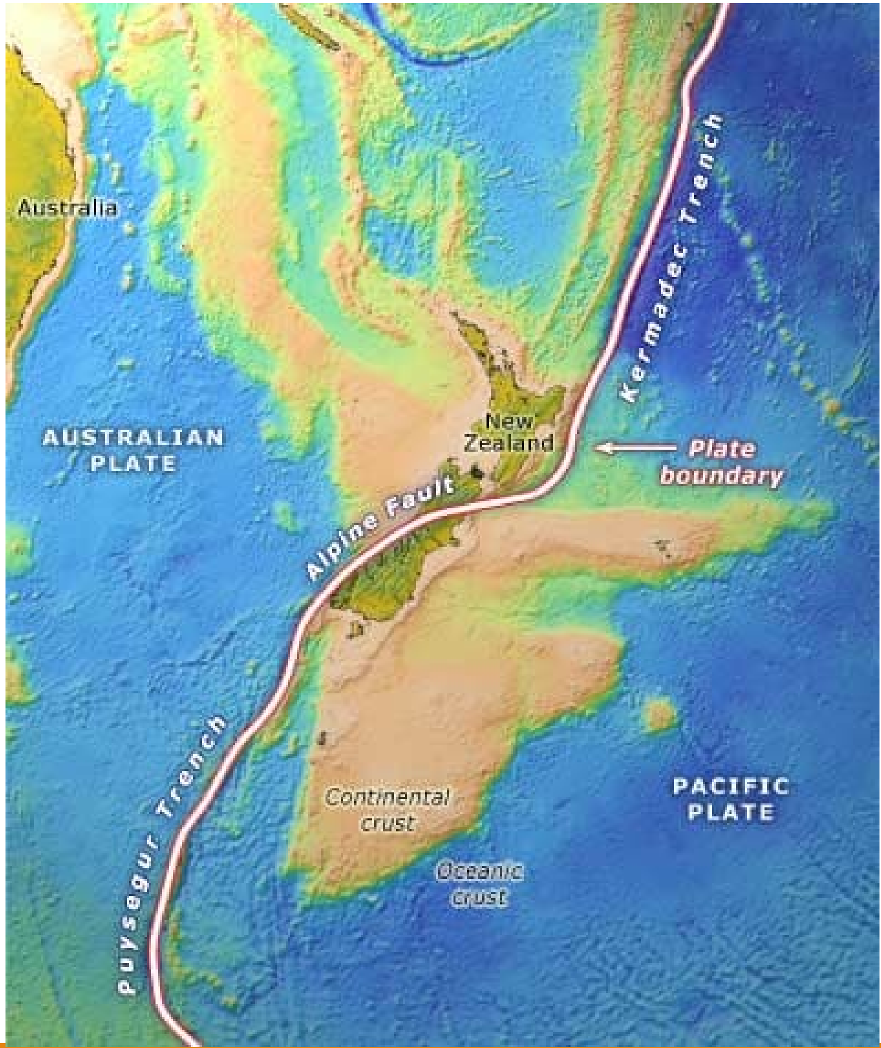
i. Earthquake Geotechnical Engineering: From Earthquakes to Better Practice
ii. Formative Years of Earthquake Geotechnical Engineering and TC203
iii. Some significant earthquakes and learnings (1980-1999)
iv. Lessons from some of the more recent earthquakes (2000-2019)

Why this contribution caught my attention?

As a both a New Zealander, and a geotechnical engineer working in New Zealand or “The Shaky Isles”, which experience over 15,000 earthquakes annually, I have a special interest in earthquakes and seismic engineering.

Recent earthquakes have had a huge impact on our country, with the 2011 Christchurch earthquakes resulting in 185 deaths and estimated $40 billion in rebuild costs[1] and the 2016 Kaikoura earthquake with an estimated $2 billion in rebuild costs.[2]

As of a result of this seismic activity, the NZ seismic code is constantly evolving, as our understanding of the country’s seismic hazard develops. Most recently, the 2022 revision of the NSHM shows that seismic hazard has increased almost everywhere throughout Aotearoa New Zealand compared to previous design values.



Brief Summary of the contribution

i. Earthquake Geotechnical Engineering: From Earthquakes to Better Practice

The importance of geotechnical effects was brought to engineering attention through a series of important earthquakes in the 1960s and early 1970s. Earthquakes which occurred in Chile, Niigata, Alaska, and San Fernando provided abundant evidence of liquefaction, soil failure and associated damage to buildings, bridges, earth dams and lifelines.

The earthquakes in the 1960s and early 1970s stimulated research groups in several countries to document case histories from these events and raised the awareness of complex phenomena and the need for their in-depth study.

In the 1980s and 1990s there was a huge increase in earthquake engineering activity, widening of scope, and significant advancements across the field of earthquake geotechnical engineering, both in research and practice.

Over the last 20 years, focus has moved towards increasingly challenging earthquake engineering problems.

Brief Summary of the contribution

ii. Formative Years of Earthquake Geotechnical Engineering and TC203

"The 1964 Niigata earthquake (MW7.5) and 1964 Alaska earthquake (MW9.2) helped to identify liquefaction as a major problem in earthquake engineering. " Idriss and Boulanger (2008).

The earthquakes which occurred in the 1960s and 1970s influenced policy makers, engineers and the research community in several countries, resulting in increased funding and re-focusing of engineering and research groups towards documenting and studying the effects of earthquakes.

An important development was the quantum jump in international cooperation in all stages, from database documentation to development and acceptance of these new engineering approaches and procedures. The essentially continuous collaboration between North America and Japan, starting after the Niigata earthquake, played a most significant role in this process, establishing an important precedent that continues to this day.

Kenji Ishihara started technical committee 4 (now TC203). After the San Francisco Conference in 1985, he thought it necessary to activate the technical committee, and organized a small workshop-type conference in Tokyo. Dr. I. M. Idriss came to Japan to activate the newly born Technical Committee No. 4.

Brief Summary of the contribution

iii. Some significant earthquakes and learnings (1980-1999)

Historical earthquakes have taught the international geotechnical community lessons for future designs:

- The 1985 Chilean earthquake resulted in 177 fatalities. One of the main lessons learned is associated with the phenomenon of topographic amplification.
- The 1985 Mexico City earthquake resulted in nearly 10,000 fatalities. The earthquake motivated seismic site response studies that led to increasing the amplification factor for soft clay sites.
- The 1989 Loma Prieta, California earthquake led to improved intensity-dependent short and long period site amplification factors.
- The 1994 Northridge, California earthquake motivated an increase in the building code-specified design shaking levels for structures sited near major active faults.
- Various soil improvements as liquefaction mitigation measures were demonstrated to have clearly reduced soil settlement during the 1995 Kobe, Japan earthquake, however this earthquake resulted in 6,000 fatalities.
- The 1999 Kocaeli, Turkey earthquake resulted in more than 20,000 fatalities. This earthquake provided basis for design recommendations and new building code provisions for proper design against surface fault rupture

Brief Summary of the contribution

iv. Lessons from some of the more recent earthquakes (2000-2019)

- The 2004 Niigata-ken Chuetsu earthquake attracted consideration for the need for a better protection of private properties from earthquake damage,
- The 2005 Kashmir-North Pakistan earthquake caused over 80,000 fatalities. It demonstrated long-term slope instability in areas hit by strong earthquakes due to cascading effects associated with strong precipitation.
- Almost 90,000 people were killed in the 2008 Wenchuan, China earthquake. This earthquake resulted in the revision of the seismic hazard map, the design seismic code for buildings and infrastructure, and the development of systems for risk assessment, monitoring, early-warning and prevention of landslides and debris flow.
- The 2011 Tohoku earthquake provided lessons for tsunami protection design.
- The 2010 Haiti earthquake caused over 230,000 deaths and showed clear correlation between the geological/soil conditions and building damage.

The most interesting part of the Contribution

The HTC contribution mentions that historically, the key way forward for the geotechnical industry was international knowledge sharing and cooperation. I believe this is also the way forward for the current day geotechnical community.

I was very interested and proud that the contribution notes a key legacy of the 2011 Christchurch earthquakes has been the formation of the New Zealand Geotechnical Database (NZGD). NZGD is a platform which provides free access to site investigation data across the whole of New Zealand, with the author noting that this platform has formed a critical part of many research studies.

Questions to the Author of the Contribution

i. What is the authors expectations for the future of the geotechnical community? Should we be designing structures for minimal damage? Or is some level of damage acceptable provided there is no building collapse, given the price of design and/or ground improvements?

ii. Should there be an internation law that every country have a requirement that buildings should be designed to allow for zero deaths or severe damage in a design earthquake?

iii. Should there be an international law formed which stipulates the sharing of findings from seismic events by Governments?

iv. How can we educate people better on how to react in an earthquake to protect themselves better, especially in developing countries? Could ISSMGE sponsor public awareness campaigns internationally?

Expectations on the Future of the Geotechnical Community

As has been discussed in the contribution, the key way forward for the geotechnical community industry is continually knowledge sharing. I would expect that our communication throughout the geotechnical continually improves and evolves in the future, in line with rapid advances which are occurring in technology. It would be great to see other countries setting up their own geotechnical information sharing databases, similar to NZGD.

It would be good to see strong participation of the geotechnical community in the ISSMGE initiative 'Geo-Engineers Without Borders' (GeoWB). This committee sends volunteer geotechnical engineers from the ISSMGE network around the world to areas which have been affected by a Geo-disaster. GeoWB notes that the missions they have completed over the past few years has proved the need for reliable and motivated local geotechnical engineers among ISSMGE who would be ready to volunteer and provide intervention.[3]

References

[1] Wood, A., Noy, I., & Parker, M. (2016). Bulletin Vol. 79, No. 3, February 2016. Reserve Bank of New Zealand.

[2] Stuff. (2016, December 15). Kaikoura earthquake: State Highway 1 repairs to cost up to $2 billion. Retrieved from Stuff: https://www.stuff.co.nz/national/nz-earthquake/87591527/state-highway-1-repairs-to-cost-up-to-2-billion#:~:text=The%20cost%20of%20repairs%20to%20State%20Highway,Council**%20*%20**Temporary%20fixes%20for%20freight%2Donly%20services**

[3] ISSMGE (2025, August 10). Geo-Engineers without Borders. Retrieved from the Internation Society of Soil Mechanics and Geotechnical Engineering. https://www.issmge.org/committees/geo-engineers-without-borders