ABBOTSFORD LANDSLIP DISASTER

LESSONS TO BE LEARNT

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engineering new zealand
te ao rangahau

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This document summarises the webinar by Nick Rogers, a geomorphologist and geotechnical specialist. Nick has just retired from Tonkin + Taylor where he was a Director for 20 years and at the time of his retirement was a Technical Director, and is a natural disaster assessment specialist.

Nick was one of the first professionals on the scene at the Abbotsford landslip disaster in 1979 (along with Errol Chave, who was the engineer for the Ministry of Works, and Ian Mackellar, the geologist with Geological Survey, GSIR).

In April 2020, Nick co-presented the results of a critical analysis of the shrink swell test for expansive soils that many engineers rely on when designing or choosing residential building floor slabs. With climate change, some areas of New Zealand are going be much more susceptible to drought, which has implications for the use of this test. **Find out more**

1: INTRODUCTION

Abbotsford was part of an urban area in the Green Island Borough, lying about 8kms from the centre of Dunedin city.

Unlike many case studies, Abbotsford landslip disaster is not the story of an engineering professional making a mistake. However, this disaster, and the subsequent Commission of Inquiry, changed the way society and councils account for losses arising from natural hazards, in particular landslides.

Councils have effectively transferred the liability arising from geo-hazards to geotechnical engineers and engineering geologists. This is an issue for geotechnical specialists, as complex and dynamic natural systems are not easy to analyse.

43 years after Abbotsford, actual or potentially unstable land is still being developed and built on, signed off by an engineering profession (CPEng and CPEngGeol). This demonstrates that a key lesson from Abbotsford has not been learned, with many engineers with structural engineering training also claiming geotechnical competence.

2: WHAT HAPPENED

Before the landslip disaster on 8 August 1979, the land at Abbotsford was already unstable. Nick, as part of the team at Brickell Moss (now Aurecon), had been engaged to investigate and analyse what was happening to the slow-moving ground that was causing damage to the residential buildings built on the land. The purpose of this involvement was to see if the Earthquake Commission could hold the council to account for the damage that was occurring.

THE LANDSLIP

Late on the evening of 8 August 1979 a very large landslide 'suddenly' occurred at Abbotsford, severely damaging 69 houses. (Interestingly, although all the houses ended up in terrible disarray down in the landslide scarps, most of the roofs seemed to be absolutely fine, evidence, as suggested by Errol Chave, that the roofs had been over designed.)

The landslide had been moving slowly for two months. Because it was so slow moving, it was assumed that it would continue to move slowly, and eventually arrest itself. This is what was happening with similar slow-moving landslides in New Zealand, like the West Taihape landslide where 206 houses on it are still moving, and it seems unlikely that the movement will accelerate.

At Abbotsford, 69 houses fell down into the multiple grabens that were across the block slide, largely at the head of the slide.

Nobody died as a direct result of the landslide.

BACKGROUND

Disaster insurance in New Zealand was first introduced in 1941 with the War Damage Act, and the government started accumulating money to fund damage repairs in the event of invasion. When it became evident that all this money wasn't needed, the government added potentially large-scale natural disaster events such as earthquake (in 1944) and volcanic eruption (in 1949) into the mix.

- It wasn't until 1970, that '*landslip*' was added to the list of perils covered by the New Zealand Government's Natural Disaster Insurance Scheme, originating from the Earthquake and War Damage Act 1944.
- In 1978, amendments were added to the Local Government Act 1974, which made it difficult for Councils to allow subdivision or building on land subject to land slippage from natural hazards.
- Later amendments would make it almost impossible for Councils to allow subdivision or building on land subject to, **or likely to be subject to**, land slippage (amongst other hazards).

As documented in the article *As Safe as Houses* by Rogers and Taylor (NZ Engineering 1986), Councils found this a bitter pill to swallow. Councils could no longer issue a building consent for land that they had previously issued subdivision consent for.

So, the key issues with the slow-moving landslip at Abbotsford, was whether the local authority could be held accountable for allowing building development on the clearly unstable land? And could the Earthquake Commission hold the local authority to account for the damage that was occurring?

RECOMMENDATIONS AND AMENDMENTS

The Government of the day ordered a Commission of Inquiry, largely because of the sheer scale of the landslide and the public demanding to know how this could happen in a residential area.

The Commission didn't attribute any blame for the landslide. A political cartoon at the time showed Commissioners sitting around the table with one saying, *"how about that's the way the cookie crumbles*" and another suggesting "*that's the way the grapefruit squirts*".

Many of the Commission's recommendations were, however, acted upon.

Recommendations

At the time of the disaster, buildings were insured but not land. As a result of the Commission of Inquiry:

- **Land cover** was introduced into the Natural Disaster Insurance Scheme in 1984. At the time of the disaster, you couldn't act to prevent building damage from occurring. Before the Abbotsford landslide accelerated, everyone had been watching cracks occur in the ground, and get bigger, but there was no insurance cover at that time to actually 'pick up' a house and take it off the landslide.
- **Imminent loss** provisions were included in the Earthquake Commission Act 1993. *Natural Disaster* damage now includes damage that is **likely** to occur if no action is taken in the next 12 months. You can now act before disaster occurs, providing the cost of acting is going to be less than the cost of the damage.
- The Commission recommended that **no changes** should be made to the Local Government Act and the amendments which held councils responsible.
    - *'We do not consider any change should be made to local government powers in respect of land subdivision and development and building construction until there has been sufficient time to assess the effects of the Local Government Act 1974 and the Local Government Amendment Acts of 1978 and 1979.'*
    - *"We do not recommend any change to the law relating to the liability of local authorities in respect of the control of subdivision development and building construction.'*

Amendments

However, as a result of political pressure, a year later (23 October 1981) an amendment (s641A) to the Local Government Act was issued, which gave the local authority the power to issue a building consent on land that was subject to instability and not be under any civil liability if a natural disaster occurred.

This gave local authorities a free pass, and this amendment to overturn the recommendations of the Abbotsford Commission of Inquiry went virtually unnoticed (likely because of the upheavals to society occurring at the time with the divisive Springbok rugby tour of New Zealand).

The house debate over this proposed amendment to build on unstable land included the following comments.

- David Caygill (Labour):
  - Noted that '*Only 2 years prior the House was persuaded that it should be difficult, if not impossible, to issue building permits for building on land that might be subject to slippage, and that from the submissions (on the Amendment Bill) it was clear that some local authorities readily issue building permits for land that is subject to slippage, and some take much persuading to issue building permits under those conditions.*'
  - Asked *'Can the Minister explain why this particular formula has been proposed, why it is appropriate and whether local authorities have approved it?'*
- Peter Wilkinson (National):
  - Responded *that 'Everyone appreciated the need for a power to refuse building permits to avert further tragedies such as Abbotsford, but that clearly there was a need for greater flexibility to avoid the opposite position,* ***whereby progress in an area is quite unreasonably held up because of the refusal of (building) permits.'***
  - Expanded *'Because of alleged instability in that district, severe building restrictions – in some instances total restriction – have been applied by Council.* ***As a result, property values have been severely and adversely affected, and this has caused considerable distress to the local residents.'***
  - As a result, *'development in the area has been stifled, as has confidence. I thank the Minister for listening to, and giving justice to, a small group of my constituents. That was appreciated'.*

Amendment 641A of the Local Government Act

This amendment was carried through to the new Building Act of 1991 Section 36(2) and Section 72 of the Building Act 2004.

Section 72
Building consent for building on land subject to natural hazards must be granted in certain cases
Despite section **71**, a building consent authority that is a territorial authority must grant a building consent if the building consent authority considers that—

(a) the building work to which an application for a building consent relates will not accelerate, worsen, or result in a natural hazard on the land on which the building work is to be carried out or any other property; and
(b) the land is subject or is likely to be subject to 1 or more natural hazards; and
(c) it is reasonable to grant a waiver or modification of the **building code** in respect of the natural hazard concerned.

Although this amendment that was carried through lets Councils off the hook, such consented (under s72) buildings may not be insured for natural disaster damage (Schedule 3 of the EQC Act 1993), and mortgage finance can therefore be difficult to obtain.

Therefore, there is significant pressure to obtain a professional opinion that the land is not subject to instability, nor is it likely to be so.

Councils then became responsible for assessing landslide disaster risk and passed this liability on to engineering geologists and geotechnical engineers. Most Councils now require a professional engineering geologist or geotechnical engineer (CPEngGeol or CPEng) to ‘sign off’ on land stability assessments.

Unfortunately, many engineering geologists and geotechnical engineers haven’t learned the lessons of Abbotsford, and many structural engineers are also stating ‘geotechnical’ as one of their core competencies and are included under ‘geotechnical’ in the ENGINEERING NEW ZEALAND register.

3: LESSONS LEARNT

Many geotechnical professionals (and structural engineers) use assumed soil and rock parameters to undertake simplified stability analyses. Such analyses inevitably show adequate factors of safety under even *'extreme'* conditions.

The Abbotsford Landslip was a first-time failure. Like many hillslopes in New Zealand, however, it was only marginally stable. The Commission of Inquiry called it *'geologically unstable'.* It essentially had no safety margin, and needed only a slight increase in driving forces, or reduction in resisting forces, to fail.

MARGINAL STABILITY

It's a commonly held misconception that steep slopes are less stable than moderate slopes, irrespective of the geology.

The reality is that many hillslopes in New Zealand are essentially threshold slopes. That is, they've reached a slope angle that is just stable under normal conditions. They've got to a situation where they're quite happy being where they are. So moderate slopes may have exactly the same factor of safety as steep slopes.

Marginally stable slopes are very vulnerable to modification. Such modifications include cutting and/or filling. For example, Abbotsford was only gently sloping but the landslide was most probably triggered by the removal of toe support, which was required for motorway construction.

GEOTECHNICAL COMPETENCY

Since 1978, but especially since Abbotsford, geotechnical competency has been an issue for Councils.

- Some Councils have developed their own lists of approved geo-professionals.
- Most Councils rely on Engineering New Zealand to monitor the competency of their members, and therefore merely require CPEng or CPEngGeo sign off.

Building geotechnical consistency and competency

There are initiatives to improve consistency and capability in practice, including when to use geotechnical advice. Geotechnical expertise is a specialist discipline (there is no such thing as a non-specialised geotechnical engineer or engineering geologist) which is required anytime:

- a building requires the support of the ground, or is required to support the ground
- natural ground is modified from its natural state
- ground is excavated and placed as fill to support structures.

Rotorua Lakes District Council Initiative

In 2020 Richard Phillips, Senior Engineering Geologist with Tonkin + Taylor, assisted Rotorua Lakes District Council by writing the draft update to Part 2 (Earthworks and Geotechnical requirements) of the Waikato LASS Regional Infrastructure Technical Specification (RITS). See **RITS**

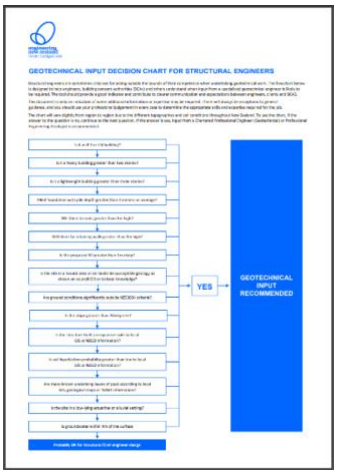
LASS, which is the Local Authority Shared Services Limited is a collaboration with eight councils, under the Waikato Building Consent Group. The purpose of their collaboration is to get consistency around the issuing of subdivision consents and building consents in that now wider area. This includes setting out geotechnical qualifications for assessing land development issues of varying complexity in different areas.

Richard's assessment was that even low risk areas still needed a geotechnical assessment.

Engineering New Zealand

In 2020 Engineering New Zealand, in association with the Geotechnical Society and structural engineers, have published a flow chart to assist structural engineers decide when it is necessary to engage a geotechnical professional. See **geotechnical input flowchart**

The flowchart approach can never cover everything, but was designed to help:



- structural engineers, building consent authorities (BCAs) and others identify if they were acting outside the bounds of competence when undertaking geotechnical wok
- enable a conversation between engineers, clients, and BCAs at an earlier stage and encourage communication
- identify when specialized geotechnical engineers are likely to be required.

Engineering New Zealand emphasises that this document is only an indication of when additional information or expertise may be required.

- It will vary slightly from region to region, due to the different topographies and soil conditions throughout New Zealand.
- It is broadly set up so that structural engineers can evaluate the job as it comes in with the amount of information available from plans through to desktop site review and ground testing.
- It should give a good indicator to the engineer, client, and BCA to make communication and expectations clearer.

But that it is only general guidance, and there will always be exceptions. Engineers need to use their professional judgement in every case to determine the appropriate skills and expertise required for the job, including geotechnical engineering expertise.

KEY LESSONS

The key lesson from Abbotsford is that before placing structures on land you need to be able to understand how the landforms have developed, how they are made up, and the processes involved. This requires geotechnical expertise, and only then do you decide if the land is suitable.

While Abbotsford was a first-time failure for that particular site, if you look wider an almost identical failure (albeit smaller) had previously occurred immediately adjacent to the site (then occupied by a *'sun club')*.

Another key lesson from Abbotsford is that if you do not understand the wider geological and geomorphological context of a site then no amount of computer-generated slope stability analysis is going to determine whether the land is suitable for residential development.

This lesson has not been learned. We continue to build on land that is, or is likely to be, subject to land slippage.

"It is unfortunate that the technology of geotechnical hazard detection and evaluation, while not always precise, is evidently far ahead of our social capacity to accept the warnings and to act upon them."

*Source: concluding paragraph in a presentation by Nick Rogers to the Auckland Branch of NZGS…**36 years ago!***

4: Q&A

Nick Rogers concluded the webinar with the following question and answer session.

Is there a different framework for slope stability risk near roads versus residential areas?

While Waka Kotahi New Zealand Transport Agency use the **ARL method**, which has come across from Australia to look at risk to road users, we haven't adopted that as a tool for residential use. Basically, your analysis should be the same, irrespective of whether you're designing for a road or a subdivision or an individual property owner or anything else.

Which soil rock investigation methods, such as CPT, boreholes or test bits, should be undertaken for assessing a slope stability issue?

Core drilling, where you're boring continuously so don't lose any of the materials, is the right way to investigate landslides. You look to see just where it is shearing. For Abbotsford, it was only after the event that a 20 mm thick rich layer of clay was identified. It was this very low angle block that the landslide was actually sliding on.

Core drilling is still the appropriate method of investigating landslides or ground conditions where you think that landslides may occur. Look at the materials you've got and undertake the appropriate testing based on whatever you happen to find.

You mentioned that the Abbotsford slip was caused by a road cutting affecting the toe. Can you please expand on that?

The material removed was from Patterson's Quarry. Part of the toe was used for some road construction, but it wasn't truncated by a road.

There were two landslides, East Abbotsford and West Abbotsford. One was triggered in terms of the motorway construction, but this was just a borrow pit which was used to take material to source for motorway construction. It wasn't actually in the way of the motorway at the time.

Would you support a more relaxed approach in existing developed areas, such as for extensions and garages, than for new subdivisions?

There is a case to relax on minor renovation. But people can still come unstuck. For example, we're seeing people excavating underneath their house to create more usable area, such as another bedroom. A lot of problems are arising from people jacking up their houses, putting in pretty shoddy supports, and then undertaking excavations which fail. The council in Auckland is forever chasing those sorts of activities

Anytime you cut into a slope, you should get someone to look at it first. Although that slope might appear fine behind a small cut, it may be marginally stable, and you won't know until it falls in on you.

Could you expand on how engineering geologists' assessment is getting worse?

A lot of people are under pressure to **not** do sufficient investigation. This brings risks to us and our companies as we try to assist developers, local authorities, individuals, and corporations to achieve their objectives.

How do we get clients to recognise the importance of ground investigation and appropriate geotechnical assessment?

In New Zealand the development industry undervalues the expertise required to do a good job.

One of the goals of the Engineering New Zealand flow chart (covered early in the presentation) was to help engineers identify when a Geotech assessment is needed. If it could capture 80% of issues, it may solve 80% of problems and help initiate the right discussions with clients.

In other countries, particularly in the United Kingdom, geotechnical engineers and engineering geologists have the rigor established through the Imperial College which emphasises the need to understand the ground. Their investigations, analysis and testing is much more thorough than in New Zealand.

So, we need to value and recognise the expertise needed to do a good and thorough job.

Is there a case for much tighter subdivision approvals, or has the recent Urban Development National Policy Statement (NPS) trumped slope stability aspects?

I think there is. You should never allow a subdivision lot to be created which has a medium risk of causing damage to a property or people who use that land.

A lot of land is still being subdivided and we are moving into more marginal areas. At the same time the climate is changing. This is a perfect storm, and as a result we're going to see more residential buildings damaged and people dying as result.

Do we need more legislation or more industry tightening to protect us? How do we do that? We look outside, but we still need to look at ourselves. Who is the problem here? In some cases, we're the problem.

What's your view on where S72 provisions are suitable to be applied under the Building Act 2004? That is, what constitutes adequate provision in your view?

The Act was junk legislation which got rebranded as enabling people to do what they wanted to do – it was made into a civil rights and a human rights issue. But this was not the intent of the Commission of Inquiry into the Abbotsford landslide disaster. The Commission put a lot of thought into how we can prevent land that isn't suitable for building on, from being developed.

Unfortunately, we had Section 641(a), which became 36(2), which became 72. So, when disaster occurs, with those notices shown on Titles, the damage to the individuals and sometimes the communities concerned is huge. It's like everyone's prepared to take a risk until it eventuates. And insurers, banks, and council's say to the property owner, '*Well, you took the risk, and so therefore it's your problem'*.

But it's not that simple. In many cases, Section 72 is included by councils purely to limit their liability. It puts liability on to the owner and in many cases, you can only put it onto the owner if there is some hazard that is actually occurring or is likely to occur.

Determinations by MBIE estimate an event like Abbotsford to occur about every 100 years. Even though this would be an extreme event and something not likely to occur, EQC will generally refuse to come to the party.

There are a lot of problems now with properties that have notices on Titles. In some cases, the hazard was not the hazard that was actually presented, and in some cases, the hazard is not even listed on the notice of Title.

What literature is available to learn more of the geology of New Zealand?

GNS Science publish geological maps which are good. Note though, the surface lithologies and the soils, which are the problem, are not shown particularly well. Some of the industrial series maps with 1: 25,000 scale are very good. Auckland's got a whole suite of those.

The old Soil Bureau, DSR division had some very good soil maps of New Zealand. But they are no longer being produced and are quite hard to find. It's worth pursuing if you're wanting to get an appreciation of the soils and geology of New Zealand. The reason these are good maps, is that, unlike the geological maps, the soil maps of New Zealand are produced by doing an auger every chain - every 22 metres.

What about the data we're getting from the New Zealand Geotechnical Database (NZGD)? Could we be using that to be producing good quality maps?

The New Zealand Geotechnical Database (NZGD) is a fantastic tool for New Zealand. Anybody who is doing any investigation work in New Zealand can put that data onto the NZGD. It's open-source information which is the way of the future. So, get your client to agree that their new geotechnical information will be shared onto the NZGD so we can build our shared repository for our collective benefit.

Also, Retrolens gives you access to all historical aerial photography going back to the tiger moths in the 1940s! It can be used for mapping, but there are gaps still to fill.

What needs to be done going forwards to address the issues of structural engineers still not listening to the advice?

Engineering New Zealand needs to be more of an enforcer going forward, so that qualifications and competency of engineers can be absolutely relied on, for example, by local authorities. People need to be able to trust the competency of engineers.

As a student, what do you think is important to be conscious of coming into the industry?

Geotechnical is a good area in civil engineering, as solving geotechnical issues is complex (and unlikely to be replaced by Artificial Intelligence and robotics). There is a need for people who can look at a landscape and understand how that landscape formed. More particularly, to understand the processes that are actively occurring, and what climate change is going to do to those processes, as well as factors like site modification. So, consider incorporating areas like geomorphology and engineering geology into your study.

There is also a general shortage of chartered engineers and geotechnical engineers around New Zealand. We need to get people involved in engineering, geosciences, earth sciences, and promote it as a worthwhile career. For example, through initiatives like the Engineering New Zealand **Wonder Project** for schools.

Do we have a zoning of various unstable landforms for New Zealand, based on some risk ratings?

Some local authorities do, such as Rotorua Lakes District Council (working with eight councils to get a commonality of approach) and Whangārei Building Consent Group.

But we need a nation-wide approach with further investigation into unstable land mandatory by councils before they will issue a consent. The **Colab Solutions** initiative is inspiring in this regard.

Looking at the geomorphology of the area. Was there any indication of previous slips in the Abbotsford area, apart from the one mentioned on adjacent land?

Yes, it was right alongside Abbotsford and became incorporated within the wider slip. It was staring at everybody, but most people missed it. People needed to be concerned earlier than they were, asking '*would this thing accelerate and turn into total custard?*'.

This is similar to the west Taihape landslide situation where there are other similar landslides in the area, although not immediately alongside. West Taihape has 206 houses, and until fairly recently, a primary school sitting on it. There was a decision that it wasn't appropriate to have a primary school sitting down the toe of this very large albeit slow moving landslide in Taihape, and so it was relocated to a safe site.

Has New Zealand got a situation, from analysing core samples, of geological layers that contain a thin layer of deposited volcanic ash that causes a sudden slip when saturated?

Some examples are:

- Omokoroa, which has thin quick clay evident. Quick clays tend to change from a relatively hard condition to a relatively liquid mass if disturbed.
- Tauranga Beds, where you see tertiary sedimentary smectite rocks, which change into block slides with low angle failures.
- In 2008 in Auckland due to prolonged rainfall, we saw large landslides undergo movement again (which we hadn't seen for 40 years).

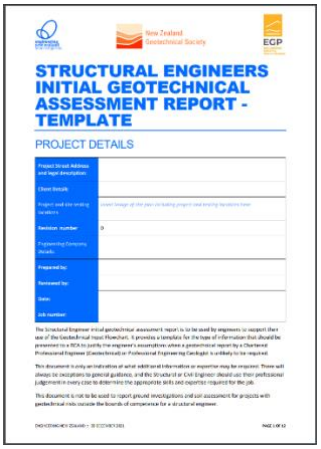
As we head into areas with a wetter regime, not quite a pluvial, but a much wetter future, we will likely see more of these. They're already in the landscape, although they haven't moved yet, we now realize the reason is because we haven't had prolonged rainfall.

We've had high intensity rainfall which causes the shallow failures, but we haven't yet seen big failures move due to much higher groundwater levels. These often take months, sometimes years, to develop.

How do you suggest we get local councils to take geotechnical investigations seriously?

Engineering New Zealand has been working on agreeing good geotechnical practices with the Geotechnical Society and Engineering General Practitioners Group. Last year they put out a **template for a structural engineer** to use when they're doing an initial geotechnical assessment report.

Engineering New Zealand continues to work with the Geotechnical Society, and Structural Engineer Society, with input from some Building Consenting Authorities (BCAs), on what a *good* quality geotechnical report looks like, and the types of information that should be contained in that.


STRUCTURAL ENGINEERS INITIAL GEOTECHNICAL ASSESSMENT REPORT - TEMPLATE

PROJECT DETAILS

Although councils set the bar of what is acceptable, many places in New Zealand have low-income levels and the cost of a Geotech investigation seems to be out of reach.

Councils therefore are pressured to accept something which isn't quite adequate. But councils have a duty of care beyond that. They should be looking at the hazards themselves independent of the private sector. They should be producing hazard maps for their areas, instead of pushing liability directly onto the structural engineers and some of the geo-professionals working in that particular area.

We need to put more pressure on councils through Local Government New Zealand (LGNZ) and politicians, to make sure local authorities are working on behalf of their communities.

Can you please elaborate on the definition of medium risk?

Medium risk, yes. It's that old catch all, isn't it?

- The middle child.
- It's not bad and it's not good. It's somewhere in between, I guess.
- We tend to put lines on stuff, and because it's impossible to put a line between low and a high, it's basically the band that's in between.
- It's a bit like the zoning in Canterbury that occurred after the earthquakes, we went into green and red and we had a lot of orange, but eventually we did manage to put the orange into either green, red.

I think with time, you should be able to have something which is, a place you can go and a place you can't go. I think that's where we're heading.

This case study is dedicated to the memory of Richard Phillips, a close friend and colleague, who died while climbing Mt Taranaki on the night of 4 May 2021.

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