CAVE CREEK - 1995 PLATFORM COLLAPSE

LESSONS TO BE LEARNT

February 2021

engineering new zealand
te ao rangahau

CONTENTS

This document summarises the webinar developed and led by Gordon Hughes (FEngNZ), a structural engineer, for Engineering New Zealand in 2021.

Gordon draws on the Cave Creek catastrophe of 1995 as one of those past failures with many lessons that are still relevant to engineers practising in today's environment.

Gordon describes how, by applying engineering skills and risk analysis methods, failures and mistakes could have been identified early and the disaster avoided.

1: INTRODUCTION

Over 25 years ago on 28 April 1995, the Cave Creek viewing platform in the Paparoa National Park in the West Coast of the South Island of New Zealand failed and collapsed. Eighteen people were on the platform at the time. Seventeen were students from Tai Poutini Polytechnic and one was a Department of Conservation (DOC) staff member. Fourteen died as a result of their injuries and four others survived (three seriously injured).

The failure of this viewing platform is important to all engineers, as the reasons behind its collapse are lessons learnt that are applicable to us all.

Some of these were engineering issues (only a basic understanding of structures is required), but there were also wider system issues.

This case study looks at:

- what happened
- why the platform failed
- general causes of failure
- lessons to be learnt, and
- implications for practice.

Cave Creek/Kotihotiho

*LINZ DATA SERVCE (**https://data.linz.govt.nz/)***

2: WHAT HAPPENED

The students were studying outdoor recreation at Tai Poutini Polytechnic in Greymouth and visiting Punakaiki for a field trip – in particular the site of the Cave Creek resurgence. DOC had constructed a timber viewing platform to provide visitors with an amazing view over the landscape.

When 17 of the Polytech students and a DOC Conservation Field Centre Manager crowded on to the timber viewing platform high above Cave Creek, the platform collapsed and fell about 30 metres into the chasm below.

Carolyn Smith was one of the survivors and describes her experience…

"We continued walking and, as the track became narrower, walked in pairs. I was in approximately the middle of the group as it reached the platform and stepped into a gap on the left-hand side of the platform at the front to have a look. I looked over and went to take a step back because I don't like heights. Suddenly, and with no warning except for yells of surprise, the platform was falling under our feet. It began sliding down at approximately 30 degrees and then tipped and fell vertically with everyone falling in front of it."

COMMISSION OF INQUIRY

A Commission of Inquiry was held, and the findings were released on 10 November 1995. It identified why the platform failed and made recommendations to prevent a disaster like this happening again. (For a copy of the report go to **https://www.doc.govt.nz/news/issues/cave-creek/**)

As part of the inquiry a model of the deck was created, to help understand why it failed.

3: PRIMARY REASON THE PLATFORM FAILED

The Commission of Inquiry found the dominant reason for the platform failure was the design and construction of the platform.

"…it is clear that the proximate or dominant cause of the collapse was that the platform was not constructed in accordance with sound building practice. This resulted in a catastrophic failure."

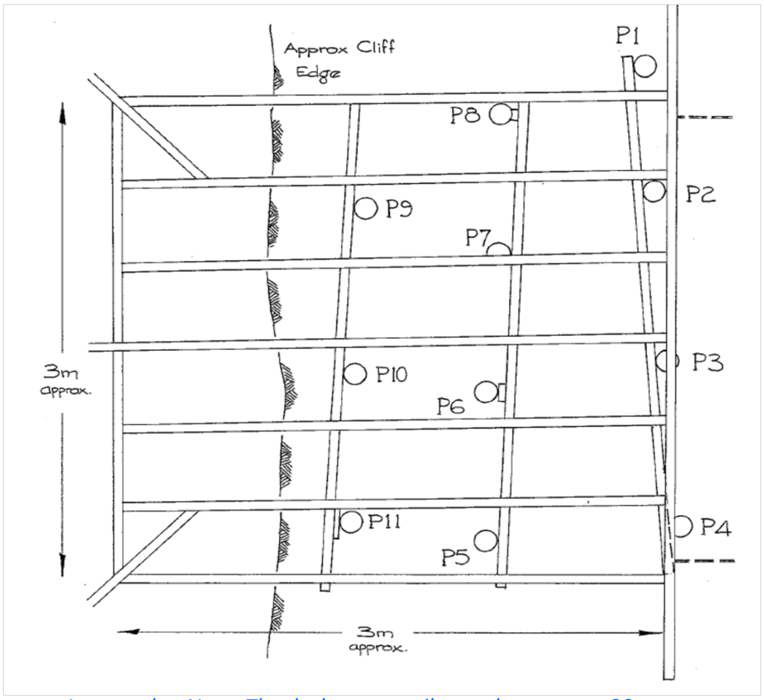
This finding was supported by the following evidence.

PLATFORM DESIGN

The deck had been designed by a DOC staff member who was trained as a motor mechanic.

- There was no structural or geotechnical engineering design input.
- No building consent was obtained prior to construction (a retrospective application was proposed but did not proceed).

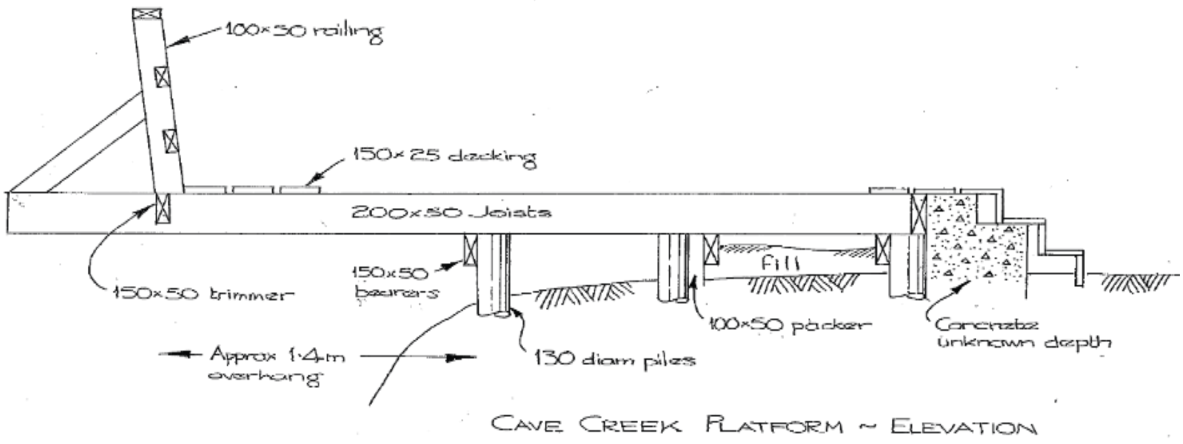
The platform foundation consisted of three rows of wooden fence posts, each between 110 and 140 millimetres in diameter, driven vertically into the ground as piles. They extended between 200 and 400 millimetres above ground level and were within an acceptable height tolerance of approximately 20 millimetres of each other. The rear row contained four piles, as did the centre row but these rows were not parallel to each other), and the front row contained three piles approximately parallel to but offset from those in the centre row.



Layout plan Note: The deck was cantilevered out over a 30 m ravine to provide the best viewing of Cave Creek. (Australian Journal of Structural Engineering, Vol. 15,) No. 1, 2014: 111-120

To the front of each row of piles had been nailed a 150 x 50-millimetre timber bearer fastened at each pile by two 100 x 4-millimetre galvanised flat-head nails. Because three of the piles were slightly misaligned in their row (i.e. those designated P11, P8 and P6 on the plans) 100 x 50-millimetre wooden packers had been used to fill the space.

Onto and at right angles to the bearers, seven 200 x 50-millimetre timber joists had been attached to the bearers by use of two 100-millimetre skew nails, and with 200 x 50-millimetre timber trimmers fixed to each end of the joists.



Cross-section plan. (Australian Journal of Structural Engineering, Vol. 15,) No. 1, 2014: 111-120

On top of the 20 joists was nailed 150 x 25-millimetre timber decking, and 100 x 50-millimetre timber handrails were created around three sides.

The platform when constructed measured about 3 metres square and overhung the front row of piles by about 1.4 metres and the face of the resurgence by slightly less.

At the rear of and abutting the platform, concrete steps of indeterminate depth and weight had been constructed. These had been surfaced with timber and the rear platform had been attached to this by the insertion of 75-millimetre nails into five timber dovetails set into and as part of the original boxing for the concrete steps.

The timber was Pinus radiata, generally of No. 1 framing grade. It is unknown as to the type of treatment, if any, had been given, but Hazard Class specification H3 had been ordered. That would have been satisfactory for the deck but unsatisfactory for the timber in contact with the ground, as were the rear and middle bearers, where mounding of soil could eventually have led to premature decay.

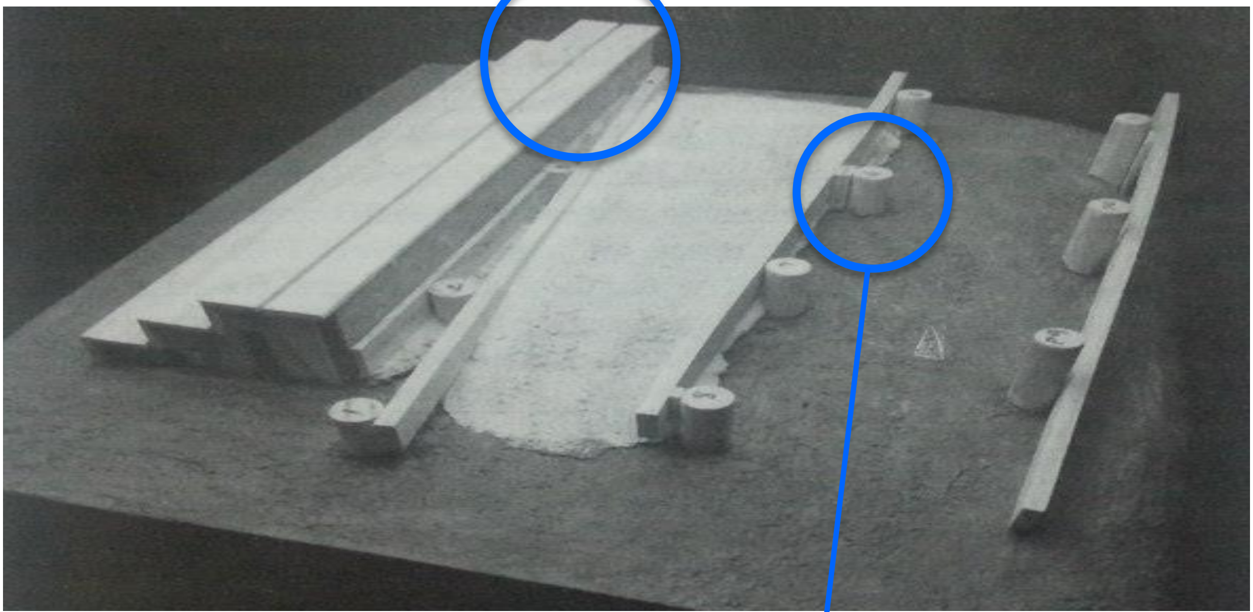
PLATFORM CONSTRUCTION

The platform was built by DOC staff. Due to the remoteness of the site the platform was prefabricated and lifted to the site by helicopter.

The Commission of Inquiry found that the standard of workmanship was adequate for the deck fastening but was substandard in the following areas:

- Piles were not properly set out and aligned.
- Packers were used for bearer spacing to misaligned piles.
- A nail only dented a pile on bearer joist 2 and did not significantly penetrate the pile.
- Some joist to bearer connections had one nail and others had nails that missed the bearer.
- Either no plan was used, or the plan was not followed.
- Normal construction practice regarding bearer pile connections was not followed.

In addition, although piles were placed and cut off at the required level, only three piles were placed in the first line, and there was some inaccuracy in pile placement.



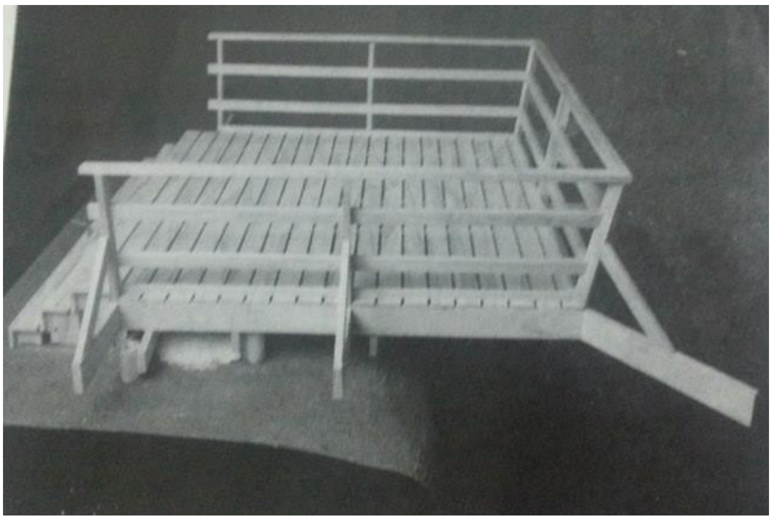
The model of the deck that was created as part of the Inquiry.

Bearers were placed alongside the piles and fixed to the piles with 100 mm nails. In some cases, timber packers were used.

The timber joists were nailed to the bearers with skew nails and the timber decking was nailed to the joists.

Timber hand railing was provided.

Concrete steps were later added but were not robustly connected to the platform.



The model of the deck that was created as part of the Inquiry.

4: SECONDARY CAUSES OF FAILURE

The Commission of Inquiry also identified a range of secondary causes for the failure.

ENGINEERING DESIGN AND SUPERVISION OF CONSTRUCTION

The Commission of Inquiry identified there was a failure to get engineering design and management. The table below has been paraphrased from the Commission of Inquiry.

Failure to Provide Qualified Engineering Input into the Design and Approval of the Project	○ When the department was created, an appropriate framework for management of design and construction of structures was never laid down and given to conservancies and then to field centres. ○ 6.2.1.2 Officers at both regional conservancy and field centre levels were inadequately instructed regarding the management of design and construction of structures. **This led to the failure to provide engineering input into the design and approval of the project.**
Failure to Adequately Manage the Construction	○ "…adequate working drawings and specifications ought to have been prepared under certification by a qualified registered engineer. They were not. ○ Such plans ought to have been strictly followed. No plans were followed. ○ Construction ought to have been carried out by suitably skilled tradespeople under the supervision of a qualified and suitably skilled carpenter. It was not. ○ The building project ought to have been appropriately planned, sequenced and managed. It was not.

BUILDING AND HEALTH AND SAFETY IN EMPLOYMENT ACTS

The Commission of Inquiry identified there was a failure to meet the statutory obligations of the Building Act and Health and Safety in Employment Act.

Failure to comply with statutory requirements and in particular the Building Act	○ Building consent - A Building Consent was not obtained. Staff were unaware of changes in legislation that required a building consent. There was an attempt to obtain a retrospective building consent but this was not completed. ○ Resource Consent - The Commission found that lack of a Resource Consent (if required) would not have altered the outcome.

THE STATE OF DEPARTMENT OF CONSERVATION (DOC)

Health and Safety in Employment Act	*'...I conclude that the department was slow in its implementation of the Health and Safety in Employment Act. I accept that actual platform construction almost coincided with the act coming into force and make no criticism in that regard.* *..... that the act is also related to the safety of people at work or people affected by work, and that compliance with S.16 (taking all practicable steps to ensure that people in the place of work are not harmed by any hazard) would have ensured the safety of the public as well as those at work, I conclude that the department had an obligation to comply with the act.* *I find it likely that it did not do so in relation to hazard identification at Punakaiki before the collapse. There was no hazard identification there and employees were not given the opportunity to participate in the process in terms of S.14.* *In terms of identifiable hazards, the following practicable steps could have been taken: the input of qualified skills in the planning process, during construction having proper plans on site, competent management, direction, construction and inspection and, after construction, a regular checking and inspection system.'*
Lack of Inspection	*'... that there were no formal inspections of the platform following construction and, even if there had been, it is unlikely that the fundamental design and construction details would have been revealed.'*
Lack of Warning Signs	If the "maximum 5" sign had been in place and observed by those present on 28 April, a tragedy of this scale may have been prevented. It is conjectural whether, under a maximum load of five people, the platform would have failed then, but on the engineering evidence it would probably have failed under that loading at some time

"...the secondary causes of the collapse must be considered against the multiple background of the services provided by and the structure of the department itself, the resources of the West Coast Conservancy and its region and statutory obligations, the conservancy staff and the various pressures on them, the adequacy of the resources for the task and the increasing demands on those resources."

The Commission of Inquiry identified:

- The West Coast Conservancy managed vast tracts of land with numerous facilities in a region susceptible to emergencies of varying kinds and heavy resource management demands.
- The department had been underfunded from the outset, with difficulty in carrying out its statutory functions and duties. This under-resourcing had been a constant refrain by the Chief Executive, the New Zealand Conservation Authority and Conservation Boards and other supporting organisations or individuals.
- Visitor numbers (i.e. those making demands on the conservation estate and particularly the front country) were rapidly rising.

- Staff were very committed to the department (which was a highly regarded employer for those with a keen conservationist bent) but the lack of resources gave rise to a culture of doing more with less. Staff's difficulties were compounded by:
    - Frequent reprioritisation (a dreadful word which really means the cancellation or the postponement of a project), and
    - The anti-department attitudes demonstrated by certain sections of the community.
- Funding of the department in real terms were reducing annually.
- Staff numbers were seen as inadequate to effectively and safely carry out the department's statutory functions and duties.

LACK OF PROJECT MANAGEMENT

The Commission of Inquiry identified the lack of a department-wide project management system – either inherited or formulated by the department upon its inception. There were no effective systems of management, inspection, and control.

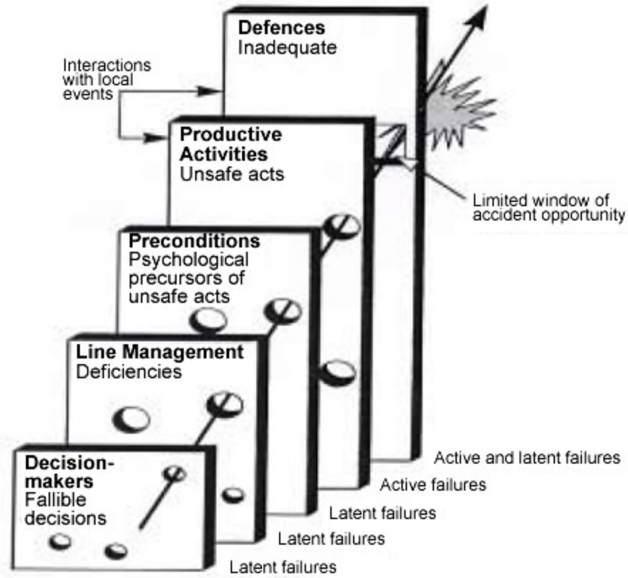
- No evidence was presented by any of the head office staff to show the existence of a proper, regularised department-wide system of project management appropriate to each of the 14 conservancies and the 66 field centres, or the existence of one pertinent to the West Coast Conservancy.
- No evidence suggested that anyone in the organisation had been given the responsibility of preparing such a system.
- The evidence (from other sources) indicated that appropriately skilled and qualified civil engineers were very competent at designing project management systems which were in daily use throughout the building industry.

In the West Coast Conservancy there were some types of (what might loosely be termed) project management systems, some of which worked well (for example, the Cape Foulwind platform project) and some of which did not work at all. It was a matter of chance whether an appropriate procedure was followed.

- Without the guidance of such a project management system, the department's employees at the West Coast Conservancy and Punakaiki Field Centre levels (conservators, conservation officers and workers) were not qualified to recognise and determine the need for qualified input into a particular project and did not so in this case. Without such guidance, it was unclear with who project management responsibility lay.
- If responsibility lay with regional conservators to establish such a system within a conservancy, then they were unaware of that, and there was no documentation from head office supporting that view.
- If responsibility for obtaining building consents (but not formulating a proper project management policy) lay with the field centre managers, then there was no adequate documentation to support that, or even that a cantilevered platform was a building. A system for obtaining necessary consents is only one element in the project management process and it is, at best, only a check system. It can never be a substitute for ensuring proper design, construction and inspection standards.

5: LESSONS TO BE LEARNT

If proper risk analysis methods had been applied at DOC, there would have been a clearer understanding of accountabilities within DOC and the public service at large.



(Sikora, 2015)

APPLYING THE 'REASON' MODEL TO THE CAVE CREEK COLLAPSE

James Reason, a Professor at the University of Manchester developed a risk model which is applicable to DOC and the Cave Creek disaster (Capper, 1966).

Reason shows that the probability of errors occurring can be predictably influenced by:

- The suitability of the individual operator to the activities they are expected to carry out.
- How well the situation or context is organised and managed which affects the likelihood of operators committing destructive errors and violations.

LIST OF CAUSES OF ACCIDENTS

This table outlines the four terms Reason attributed to accidents which are covered in his model.

Active failures	These are the direct actions - errors, violations, equipment failures, or conditions in the natural environment - which cause the catastrophic event
Latent failures	These are the deficiencies in the organisational environment which create an operational situation in which the probability of active failures occurring is increased.
Defensive failures	These are deficiencies in the procedures of the organisation which mean that it does not adequately scan activities in order to identify and remedy errors and violations before they produce catastrophic consequences.
Organisational pathogens	These are the core systemic failures which allow latent failures to develop and active failures to occur unchecked.

From the four failure causes described, Reason constructed his risk analysis model. The model can be applied to any organisation. It is shown on the next page being applied to the Cave Creek disaster and DOC.

ORGANISATIONAL PROCESSES

- Unclear policy/operations responsibilities
- Deficient project management
- No procedures for checking local manager performance
- Funding shortfall
- Inadequate training provision
- Delegations inadequately defined
- No workload monitoring
- Emphasis on financial accountability
- Contradictions between Public Finance Act and State Sector Act

ACTIVE FAILURE PATHWAY

LOCAL WORKING CONDITIONS

- Excessive workloads
- Workaholic staff
- Need for emergency responses
- Community threats to staff
- Poor relationships with Local Govt.
- Understaffed by 30
- Increased recreational use of land
- 'Do more with less' culture
- Change regulatory regime
- Restructuring

ACTIVE FAILURES

- Many construction failures
- Plans not used
- No technical survey of site
- Untrained personnel used
- No inspection of platform
- Warning signs not erected
- No Building Consent sought

LATENT FAILURE PATHWAY

DEFENSIVE SAFEGUARDS

- NZ Loading Code
- NZ Building Code
- Resource Management Act
- Project Management System
- DoC Supervisory System
- DoC Safety System
- Health and Safety Laws
- DoC Inspection

LATENT FAILURES

- Unqualified local managers
- Mismanagement of resources
- Constant reprioritising
- Unqualified staff used
- Local management unaware of legislation
- Supervisory rules ambiguous
- No clear conservancy Project Management System
- No conservancy checking system
- Unqualified engineers
- No health and safety training
- Annual inspections often overlooked

EVENT

Platform Collapse
14 Killed

6: IMPLICATIONS FOR PRACTICE

Investigating the failures and mistakes of the Cave Creek disaster has provided many lessons, from both an engineering and system perspective, and driven significant improvements.

"The disaster led to a massive overhaul by DOC in how huts, bridges, viewing platforms and structures were planned, constructed, managed and monitored.

No prosecutions eventuated, partly because the Building Act and the Health and Safety in Employment Act exempted government departments from prosecution. Six years after Cave Creek, law changes were made to make government departments liable for breaches under these Acts.

None of the positive changes resulting from the disaster can bring back the people who lost their lives and futures.

Lessons have been learned, failures exposed, and systems changed so that the pathway that led to the tragedy will never be repeated.

I feel that every time I sleep in a DOC hut, cross a swing bridge or stand on a strongly constructed platform, I'm standing on the legacy of all those who died."

(Fleur Pawsey, sister of Kit Pawsey, 20th anniversary speech)
*From **https://www.doc.govt.nz/news/issues/cave-creek/25th-anniversary-of-the-cave-creek-tragedy/***

RESULTING CHANGES

These 11 lessons were implemented by the Government and DOC.

- **Lesson 1** Change the law to provide for the prosecution of Government departments under the Building Act and Health and Safety in Employment Act.
- **Lesson 2** Implement an effective project management system to increase communication and ensure the correct procedures are followed.
- **Lesson 3** Ensure all designs of structures are carried out or certified by qualified persons.
- **Lesson 4** Ensure construction of structures is supervised by experienced, qualified personnel who understand the construction plans and specifications.
- **Lesson 5** Implement a peer review system.
- **Lesson 6** Promote health and safety.
- **Lesson 7** Implement protocols and procedures for reporting and following up on concerns in a timely manner.
- **Lesson 8** Conduct inspections during construction of a structure and once the structure is completed to ensure it meets the requirements of the Building Code.
- **Lesson 9** Establish a training and development system that records skill and competency level as well as managing the specific training needs associated with defined roles.
- **Lesson 10** Establish a complaints management system.
- **Lesson 11** Establish an asset management system providing for regular inspections and maintenance.

OTHER FACTORS TO CONSIDER

Other factors to consider include:

- **Competence**. The employee (while not an engineer) who prepared the initial plans did not recognise limits to his competence.
    - The Dunning–Kruger effect is a cognitive bias in which people with low ability at a task overestimate their ability. It is related to the cognitive bias of illusory superiority and comes from people's inability to recognize their lack of ability. In other words ‘we do not know what we don’t know’.
    - This raises issues for all engineers. How do we know the limits to our own competence and how can we meet the requirements under our code of ethics?
- **Resourcing**. It is clear that the department had developed a culture of ‘doing more with less’ and was understaffed and under resourced.
    - This can apply in all organisations from large to small.
    - Some examples could include working with inadequate fees, unrealistic time frames and inadequately skilled, experienced, and trained staff.
- **Load paths.** Clear and reliable load paths are vital. Have all load paths been considered including those for lateral and environmental loads? Are there alternative load paths available? How robust is the structure?
    - In this case the nailed connections were critical to enable loads to get to the ground.
    - Alternative load paths using piles checked out for the bearers would have provided an alternative load path for gravity loads.
    - Checking the piles for the bearers would have minimised the risk of minimal penetration of nails to piles for downwards loads.
    - Positive and robust connections between the concrete steps would have improved the resistance to uplift on that side of the platform.
- **Soil-structure interaction**. In a structure of this type of situation a good understanding of soil and geological information is vital.
    - Of significance is the stability of the soils at the top of the bank and susceptibility to erosion and time-dependent degradation as well as seismic effects.
    - It was reported that one pile did not find solid bearing.
- **Durability**. Mention is made in the Commission of Inquiry’s report about unsuitable treatment of timber where in close contact to the ground.
    - Timbers used should have the appropriate treatment.
    - Similarly, connection durability should be evaluated in terms of environmental factors and proximity to the ground and moisture.
    - Note: You can download the B2 Guidance from Engineering New Zealand from the resources section. **https://members.engineeringnz.org/s/forms-and-tools**
- **Need for regular cleaning, maintenance and inspection**. Regular inspection and cleaning are required, especially for connections, and a programme of preventative maintenance implemented to ensure an adequate life for the structure.

- Note: You can download an example maintenance schedule from the Engineering New Zealand resources.

WHAT CAN EACH OF US DO?

Here are some suggestions of what each of us can do.

- Use Engineering New Zealand's library of webinars (growing all the time) **https://www.youtube.com/playlist?list=PLfmb4aWklbWBQZbMBd9SVvQ7USyx4GF5d**
- Subscribe to CROSS-AUS or similar in your discipline. Look at the Engineers Without Borders failures website **http://reports.ewb.ca/**
- Improve QA - Keep it Simple.
- Better understand the human factors for both individuals and organisations.
- Understand our own limitations and competence.
- Ongoing upskilling and learning.
- Peer to peer reviews of our work.
- Owning our mistakes and sharing them to promote better learning and engineering outcomes.
- Help create a 'Just culture' in your workplace and technical and professional organisations. Engineering New Zealand is currently exploring resources for companies to use around how to implement it.
- Share information and mistakes. This includes re-visiting past failures so a new generation of engineers can learn the lessons and we can avoid 'memory fade'.

WHAT WILL YOU STOP DOING AND/OR START DOING?

Although the Cave Creek catastrophe happened over 25 years ago, it is one of those past failures with many lessons, valid in today's environment. We will be better engineers if we take them on board.

So, reflecting on your own practice, what will you stop doing or start doing because of this?

Some questions to ask yourself include:

- How does your company check work before it goes out the door? There is a free-to-download example of a structural calculation checklist on the Engineering New Zealand website under the resources section.
- How do you ensure you're staying within your bounds of competence? What procedures do you have to resist clients asking you to undertake work you're unsure of?
- How do you ensure that what you design is built and used properly?
- How could you start to enable a 'Just culture' in the workplace? Read about how it started in aviation here **https://flightsafety.org/files/just_culture.pdf** and how it was put into practice in a health service here **https://psnet.ahrq.gov/perspective/making-just-culture-reality-one-organizations-approach**

7: REFERENCES

Australian Journal of Structural Engineering, Vol. 15, No. 1, 2014: 111-120

Noble, G.S. Commission of Inquiry into the collapse of a viewing platform at Cave Creek 1995 **https://www.doc.govt.nz/news/issues/cave-creek/commission-of-inquiry-cave-creek-report/**

Ten Years On Updated 2005 **www.doc.govt.nz/about-doc/news/issues/archive/cave-creek/ten-years-on**

NZ On Screen – Cave Creek: The Full Story of a National Tragedy **https://www.nzonscreen.com/title/cave-creek-1998**

The Cave Creek Incident: a Reasoned Explanation, Anne Isaac **http://trauma.massey.ac.nz/issues/1997-3/isaac1.htm**

Final Year Student Reports:

- University of Canterbury ENCN 470 Group 28
- D Quayle, et al - Engineering Case Study 2015
- J Taylor, et al - Engineering Case Study 2014
- O Heaslip, et al- Engineering Case Study 2013