# A Glimpse Down the Road: The Millennial Engineering Geologist


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# South African Institute for Engineering & Environmental Geologists (SAIEG)

- Positioned itself as a VA with SACNASP
- Assist in application and competency of professional registration (Pr.Sci.Nat)
- Uphold ethical and professional standards
- Accountability
- Clients can validate competency of engineering geologists they appoint
  - Professionals register
  - Ensure they are a Member of SAIEG

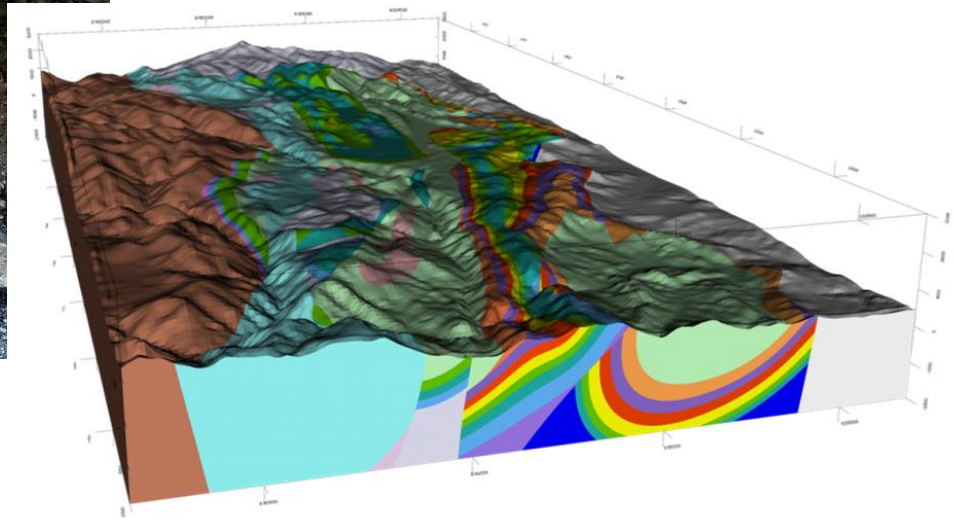
# South African Institute for Engineering & Environmental Geologists (SAIEG)

- 30% of members under the age of 40
- SAIEG have initiated the establishment of a Young Professional group.
  - Small committee to arrange social and other activities
  - Eventually develop this into a forum where younger and student members can get to know each other and interact formally
  - Regions and also internationally within their peer group.

# What will define the Millennial Engineering Geologist?

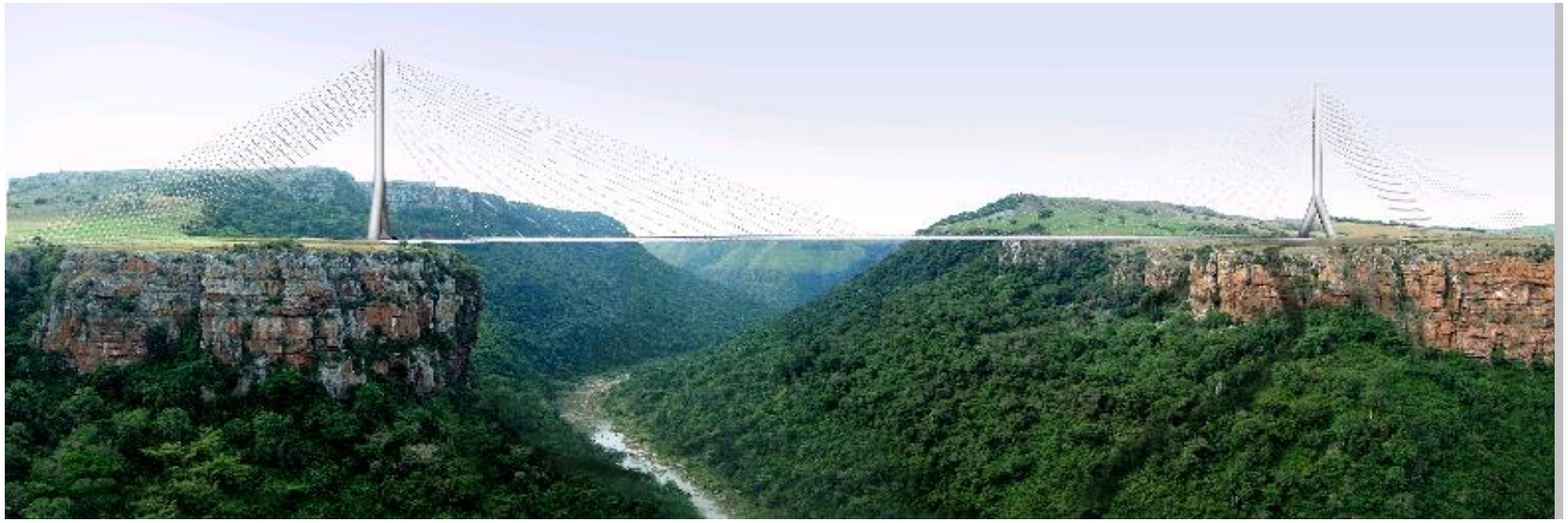
- Geotechnical risk
  - What it is and how we deal with it
- Improvements and changes to current practice
- Technology and innovation

# Ground-Related Risk



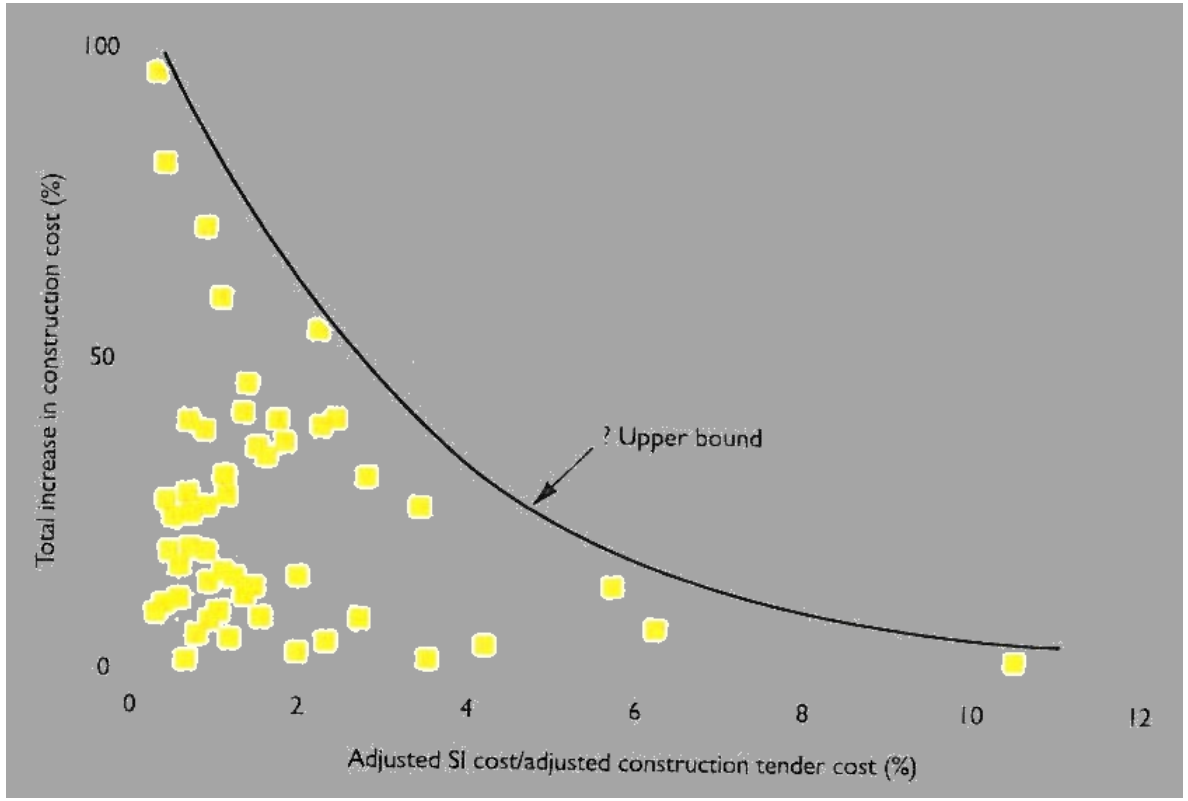
# Ground-Related Risk

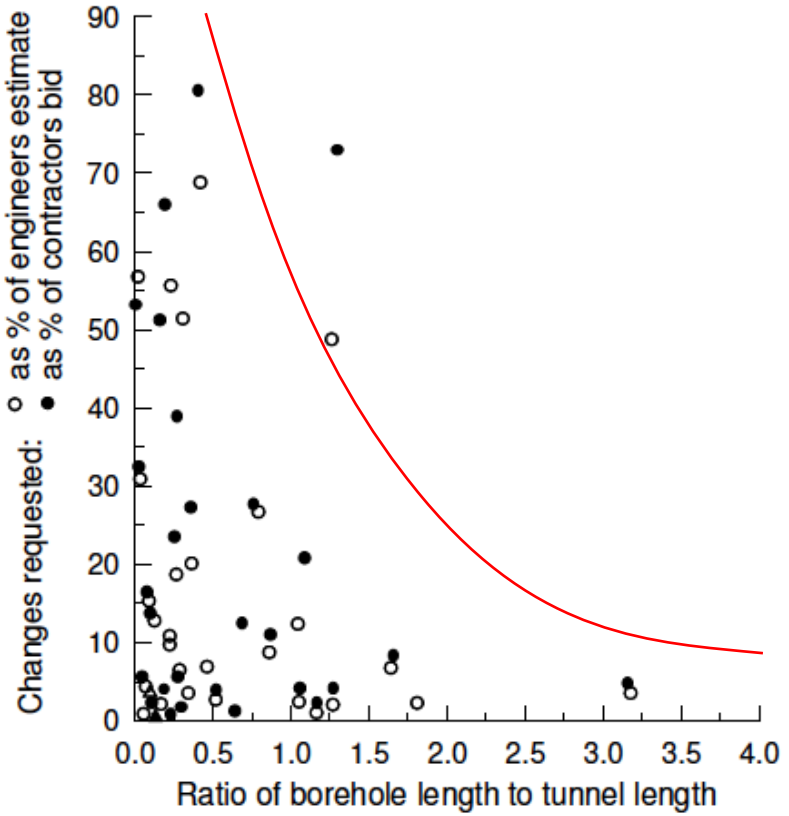
- Is the risk to building and construction works created by the site ground conditions.
- Ground related problems can adversely affect the Project:
  - Cost, completion time, profitability, heath and safety, quality and can lead to environmental damage.
- The effects on the project are often disproportionate to the time, cost and effort spent on the geotechnical investigation and design.



# Ground-Related Risk

- Cost overruns as a function of expenditure:



# Current Practice for Quarries

- 11 boreholes per hectare are drilled for a potential quarry site (SAPEM)
  - Typical NWD4/TNW sized core covers a cumulative area of ±0.125 $m^2$
  - Deduce conditions for an area of 10 000 $m^2$
  - <1% of the site area is investigated
  - Statistically insignificant
- Realistic that a site cannot be investigated completely
  - Time, cost etc.
  - Ground conditions and parameters are variable
  - Approximation at best

# Current Practice

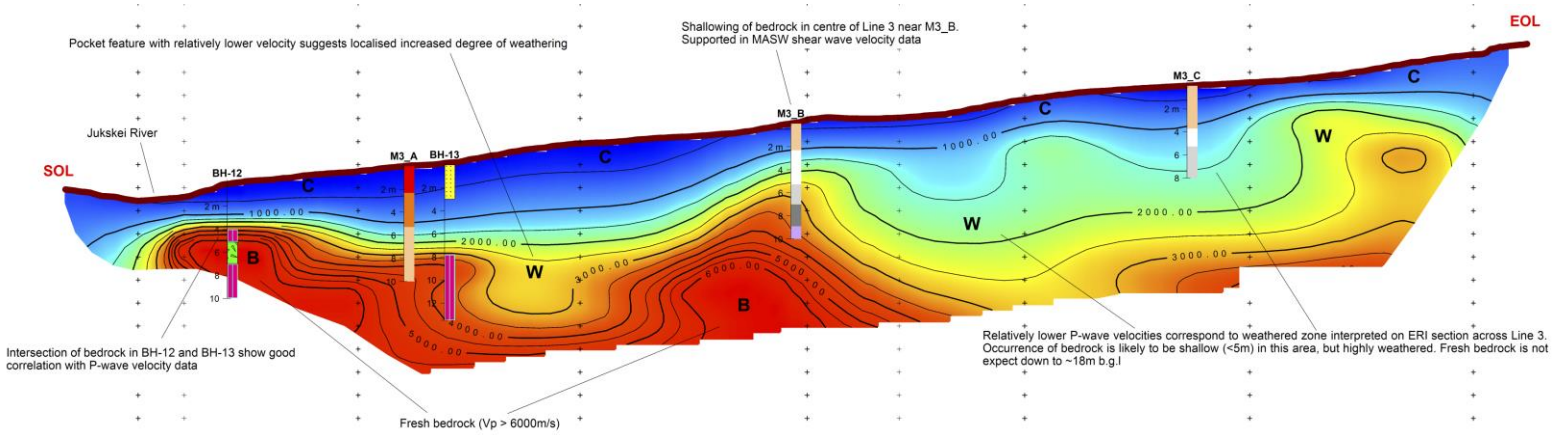
- Trial pitting:
  - TLB
  - Excavator

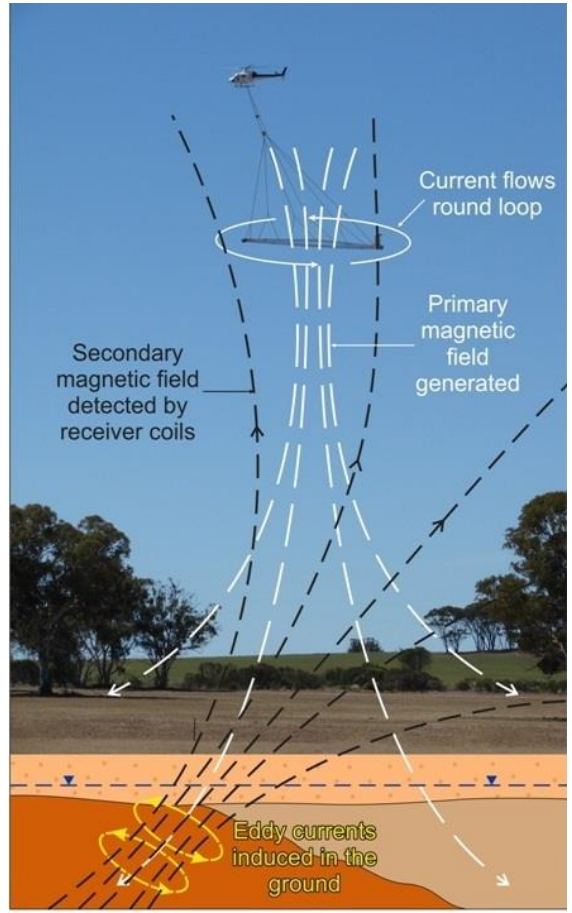
# Current Practice

- Drilling:
  - Percussion
  - Rotary-core

# Current Practice

- Geophysics:
  - Seismic refraction (SRF)
  - Airborne magnetics



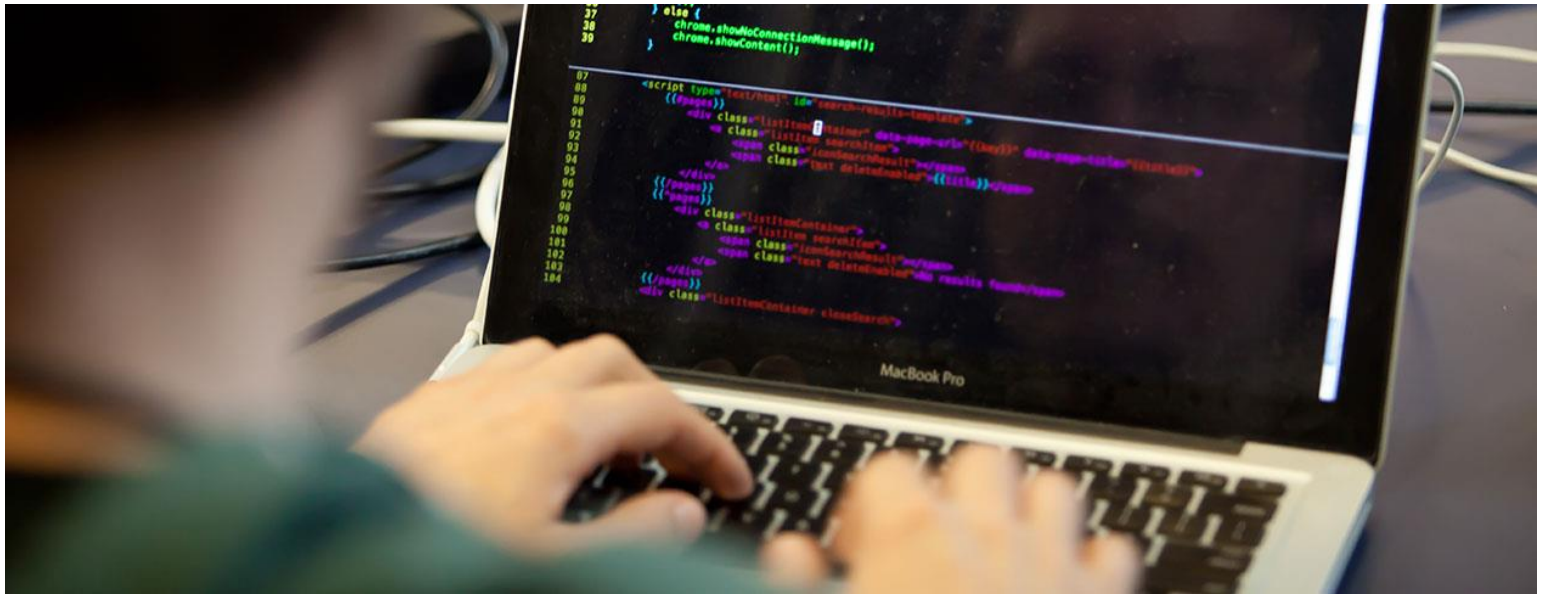



# Current Practice

- Problems:
  - Blasting
  - Crushing
  - Deleterious minerals
  - Size of fines (produced from blasting/crushing and a function of fracturing)
  - Engineering properties (Unit weight, strength, deformation, water absorption etc.)

# Developments and Way Forward

- Increased move internationally (in geotechnics) towards **codification**
- Projects in the future will be impacted significantly
- Requirements are stricter



# Developments and Way Forward

- Proposed SANS51997-1:

## K.2 Geotechnical Categories

Geotechnical structures shall be classified into a Geotechnical Category that combines the consequence of failure of the structure and the geotechnical complexity of the ground and ground-structure interaction as derived from Table K.1.

For Geotechnical Consequence classes refer to K.3 and for Geotechnical Complexity Classes refer to K4.

**Table K.1 Geotechnical Category (GC)**

| Structure complexity | Geotechnical Complexity Class (GCC) | | |
|---|---|---|---|
| | Lower (GCC1) | Normal (GCC2) | Higher (GCC3) |
| very high risk group (CC4) | GC3 | GC4 | GC4 |
| high risk group (CC3) | GC2 | GC3 | GC4 |
| medium risk group (CC2) | GC2 | GC2 | GC3 |
| Low risk group (CC1) | GC1 | GC2 | GC2 |

The Geotechnical Categories shall be used to specify the:

- minimum amount of ground investigation;
- minimum validation of calculation models;
- minimum checking of design;
- minimum inspection and control of execution;
- minimum amount of monitoring;
- minimum designer qualification and experience.

# Developments and Way Forward

- Proposed SANS51997-1:

## K.5 Design and Investigation Requirements

A proposed description and required qualifications for the various classifications of professionals can be reviewed in the informative Annexure L. Table K.4 summarises the minimum requirements for the Project Overview Level (POL), Design Level (DL) and Investigation Level (IL).

**Table K.4 Design and Investigation Requirements**

| | GC1 | GC2 | GC3 | GC4 |
|---|---|---|---|---|
| Professional Team Lead | POL1: PrEng2/PrSciNat2/PrTech3 | POL2: PrEng3/PrTech4 | POL3: PrEng4 | POL4: PrEng4 |
| Geotechnical Designer | DL1: PrSciNat1/PrEng1/PrTech2 | DL2: PrEng2/PrTech3 | DL3: PrEng3/PrTech4 | DL4: PrEng3 |
| Ground Investigation Lead | IL1: PrEng1/PrSciNat1/PrTech2 | IL2: PrEng2/PrSciNat2 | IL3: PrSciNat3 | IL4: PrSciNat4 |

The minimum amount of ground investigation and laboratory testing will be decided by the design Geotechnical Engineer and not by a third party who is not involved in the design of the geotechnical structure.

# Developments and Way Forward

- Proposed SANS51997-1:

## K.10 Peer review

Depending on the geotechnical category the client shall employ a peer review process to ensure a independent review the design. Further clarification is provided in

**Table K.10 Peer review requirements**

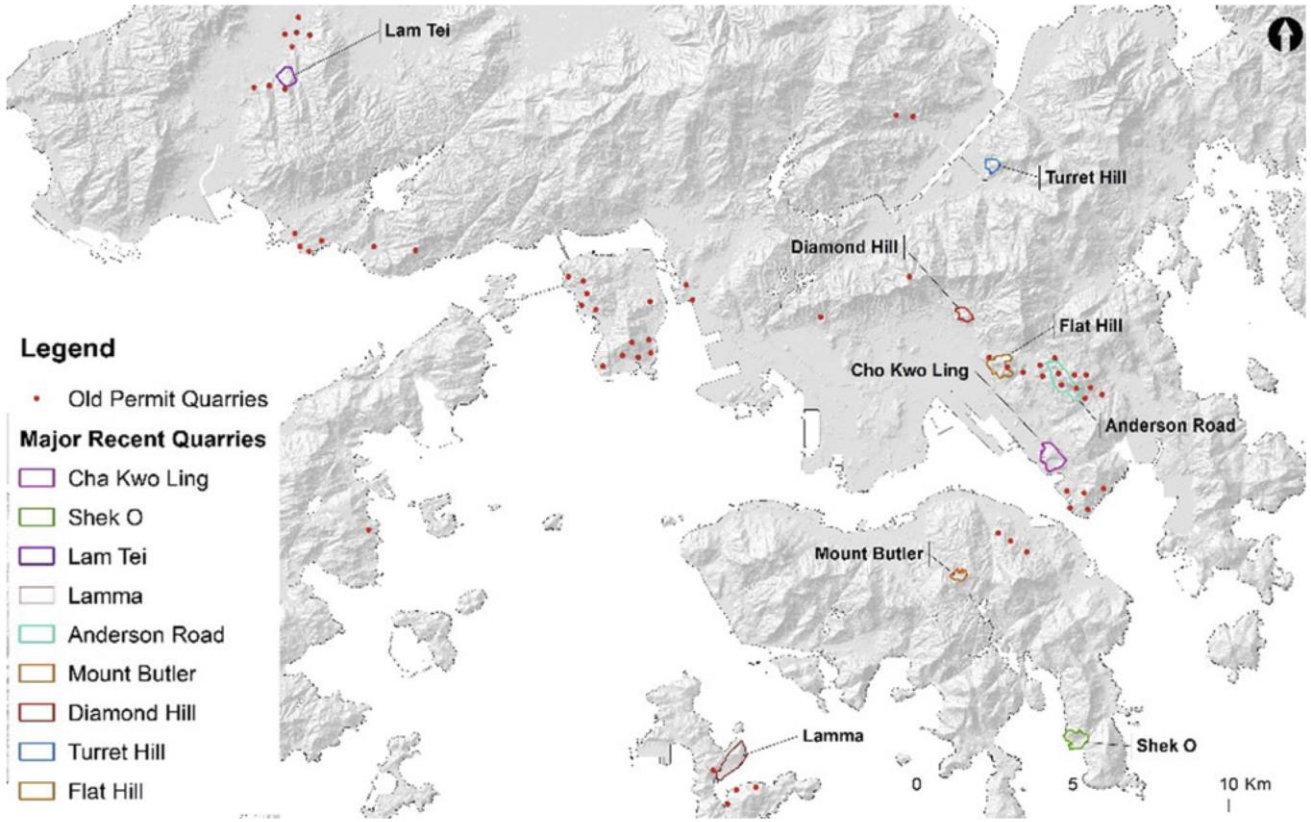
| | GC1 | GC2 | GC3 | GC4 |
|---|---|---|---|---|
| Geological Model review | Internal review by party not involved during the investigation | Internal review by party not undertaking the investigation, including a site visit during investigation | All requirements for GC1 and GC2 and, in addition, an External third party review, including a site visit during investigation | All requirements for GC1, GC2 and GC3 and, in addition External Independent third party review, with possible additional investigation required by such party to undertake such review |
| Design Review | Self review with a second calculation method | Internal review by party whom did not undertake the design | External third party review with calculations provided | External Independent peer review with own calculations |

# Developments and Way Forward

- Empirical and intuitive approach in the past
- Moving to statistical, codified and reliability-based in the future
  - Experience (intuitive) irreplaceable,
  - More valuable when used in conjunction with statistically-based
- Large amounts of data needed for a reliability and statistically based design
  - With correct tests
- Interdisciplinary approach:
  - Engineering Geologists
  - Geotechnical Engineers
  - Pavement Engineers
  - Mining and Mechanical Engineers?

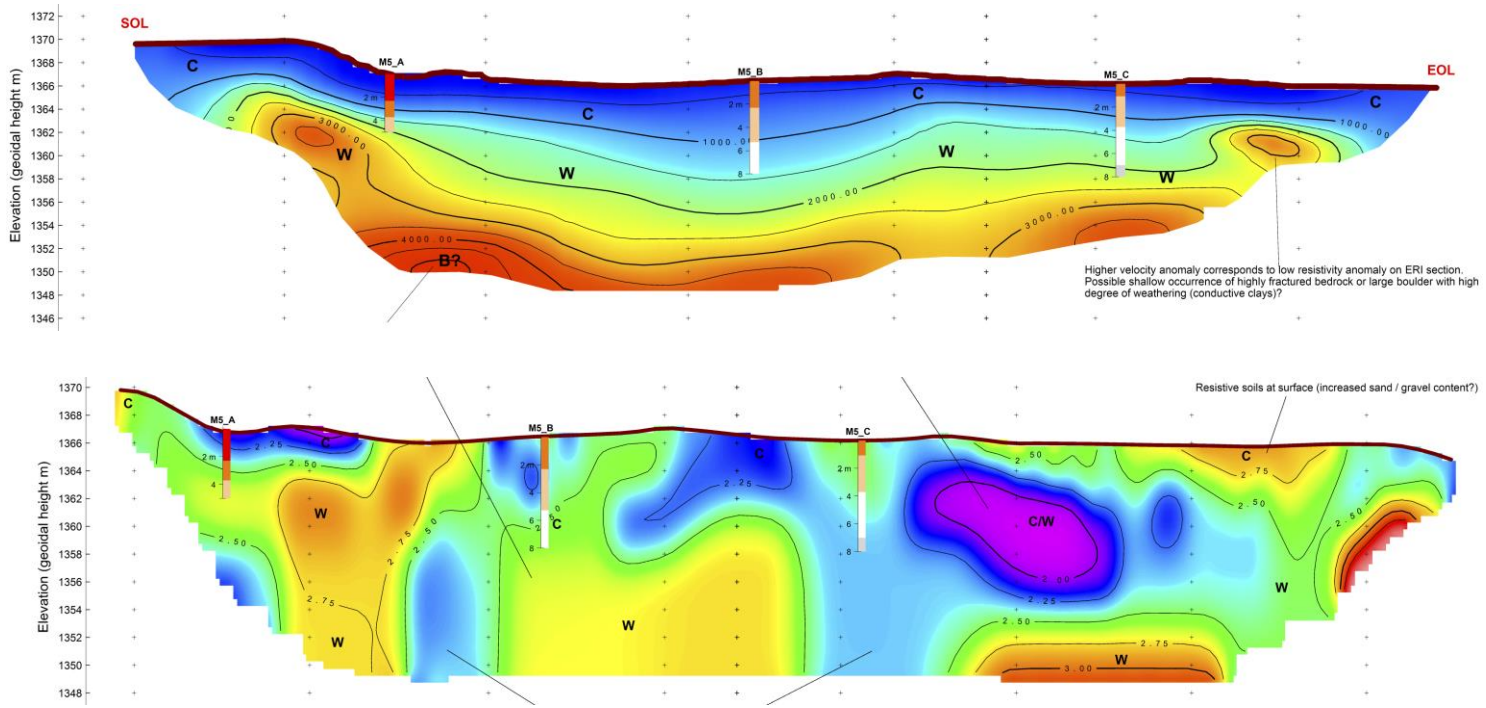
# Developments and Way Forward

- **Integrated** investigation approach
- **Systematic** investigation approach
- **Various methods**
  - Using various methods!
- Desk-study
  - Include **remote sensing and GIS** tool



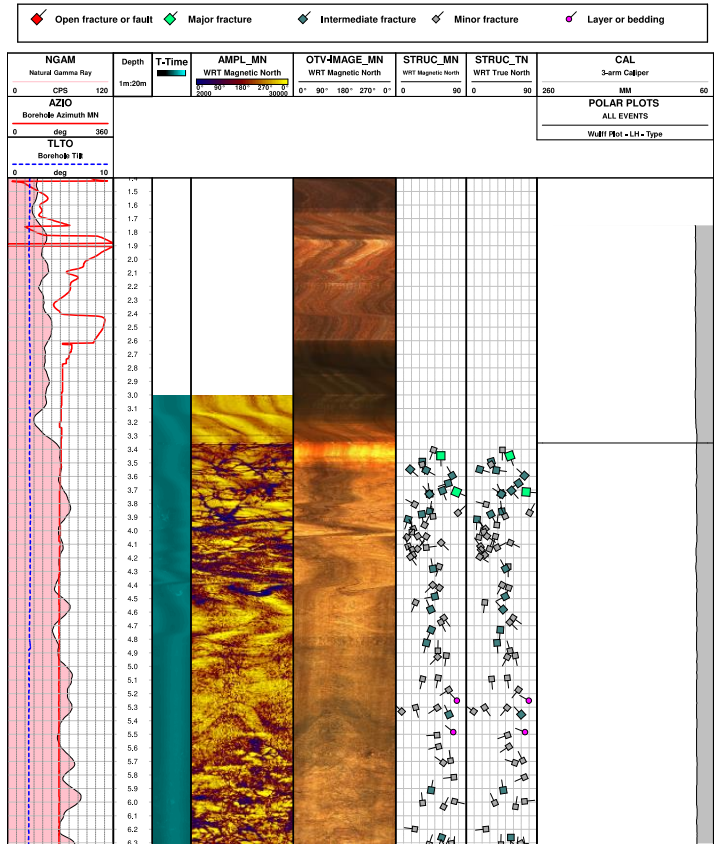
# Developments and Way Forward

- Geophysics
  - **ERI** and **MASW** to complement SRF



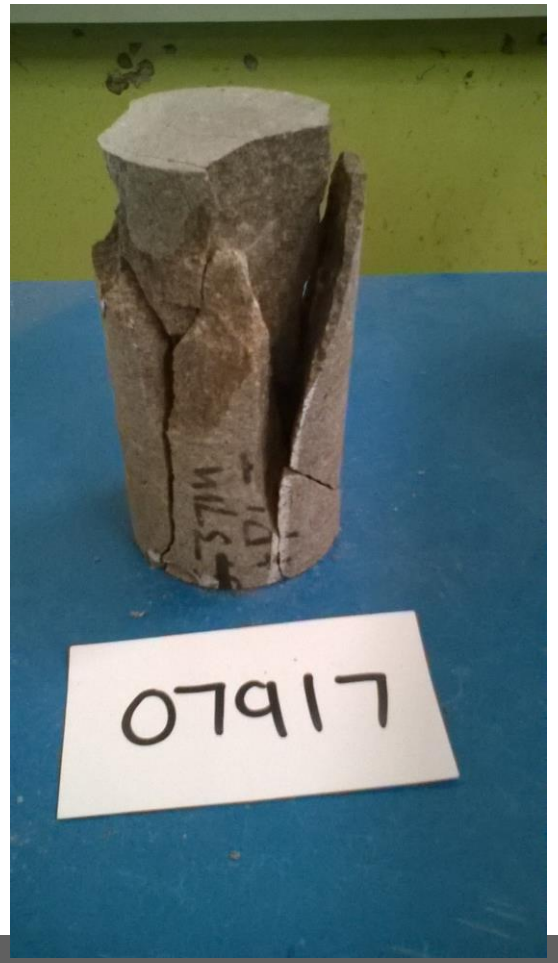
# Developments and Way Forward

- Drilling:
  - Integrate Percussive, Rotary Core, and Sonic drilling methods effectively
  - **OTV/ATV** (down the hole) to supplement poor recoveries



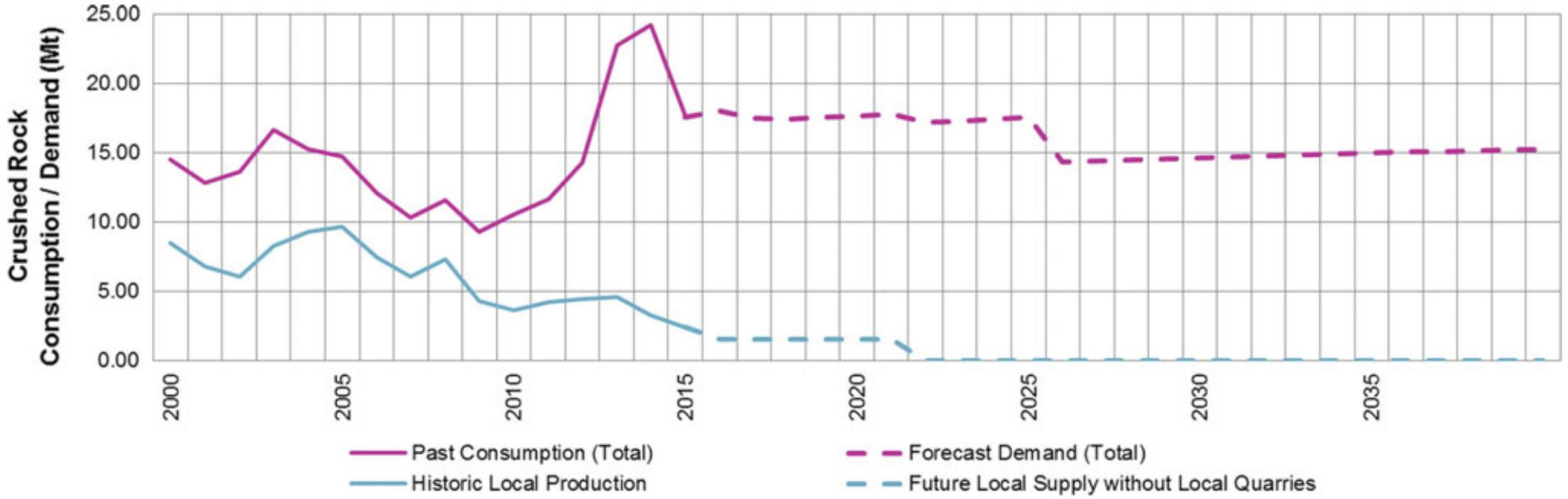
# Developments and Way Forward

- **Sufficient** laboratory testing to enable reliability-based assessment
  - **Duplicate** laboratory testing?
- Need for a **systematically integrated** approach
- Need lots of **time** to manage risks
  - Feasibility
  - Preliminary
  - Detailed-design



# Innovations

- Driven by existing megacities
- Hong Kong (Chan and Millis, 2018):
  - Underground mining?



# Innovations

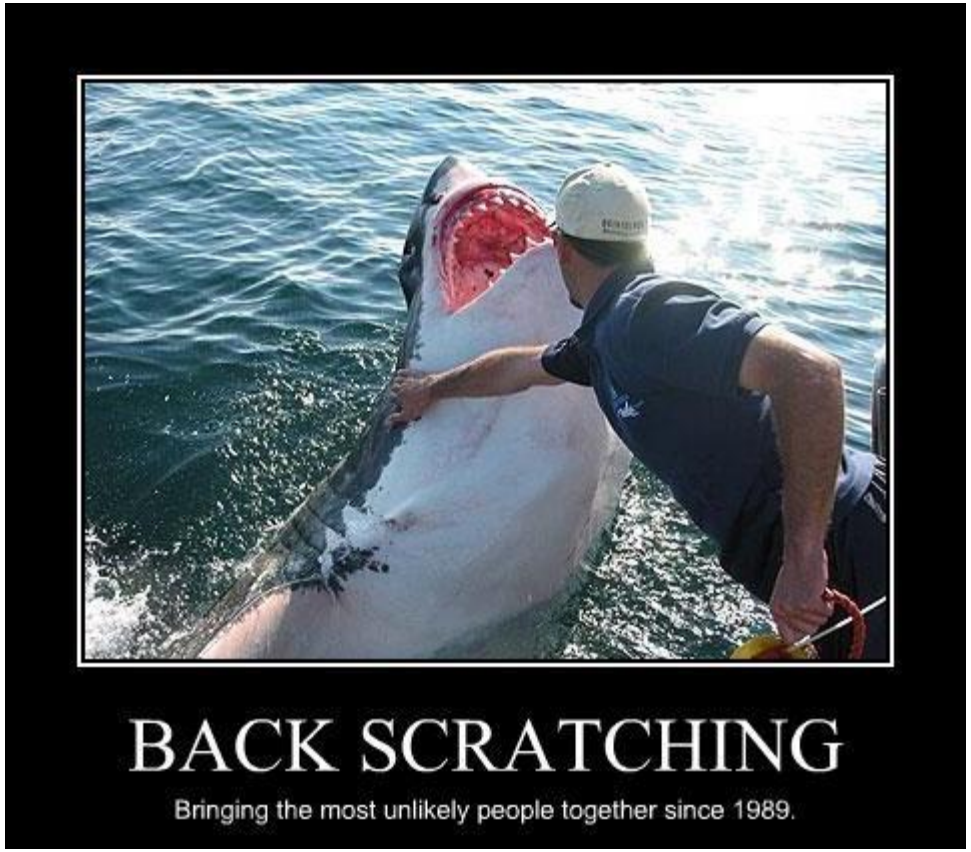
- Aggregate Mining in Istanbul (Tugrul and Yìlmaz, 2018):
- Existing problems
  - Rapidly reducing aggregates resources from existing sources
  - Increasing standards requiring higher quality aggregate
  - Rapidly increasing requirements for greater quantities of aggregates to support future development
  - Environmental impacts (limited land use, visibility, water, noise, dust and vibrations from blasting, hauling, waste material)
- Solutions:
  - Rock types, which have not been used previously, have been investigated as potential aggregates
  - Environmentally-friendly mining activities (e.g. closed aggregate preparation system)

# Innovations

- Nanotechnology
  - Marginal material can be targeted as sources
- Green roads
  - Smart drainage into quarries, instead of rehabilitation

# Summary

- How can our professions move forward together?
- Interdisciplinary approach
- CPD-validated courses
- Specific topics related to innovative developments at future Road Pavement Forums



# THANK YOU!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