

Engineers as agents

A man with a beard and glasses, wearing a black tuxedo jacket, a white dress shirt, and a black bow tie. He is looking directly at the camera with a serious expression. The background is dark blue with faint white technical drawings and sketches of mechanical parts, including what looks like a propeller or a turbine component.

DALL.E response to “Engineering James Bond”

A person that takes an active role or produces a specified effect.

Engineers are entrusted by clients to solve problems because they have the right education, experience and judgement.

Engineer

Consulting to be confident in the art and science of engineering.

Manager

Even Ivory Towers need to be oiled.



Researcher

Developing and understanding tools that engineers use

Community

Advocate within engineers and with those outside engineering.

Teacher

Pass on knowledge and inspire young engineers.

Supervisor

Facilitate adoption of best practice in a domain.

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Currently assisting a platinum mine understand its tailings dam risks

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Image © 2023 Maxar Technologies

Asked to evaluate the stability of a lined hazardous waste facility

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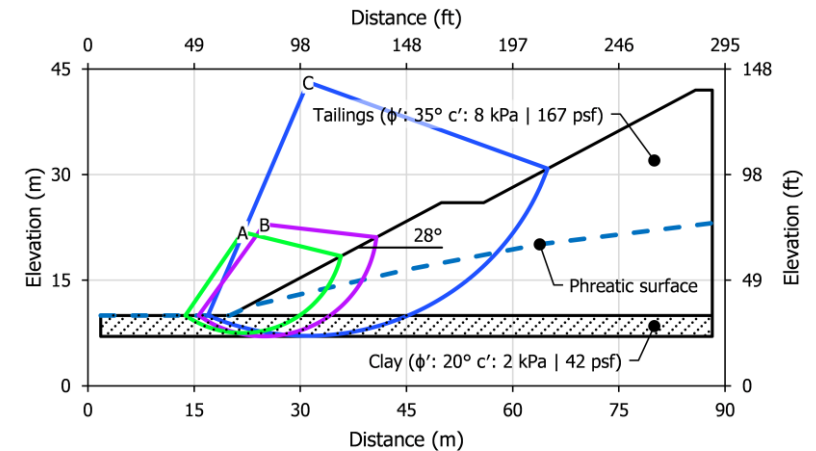
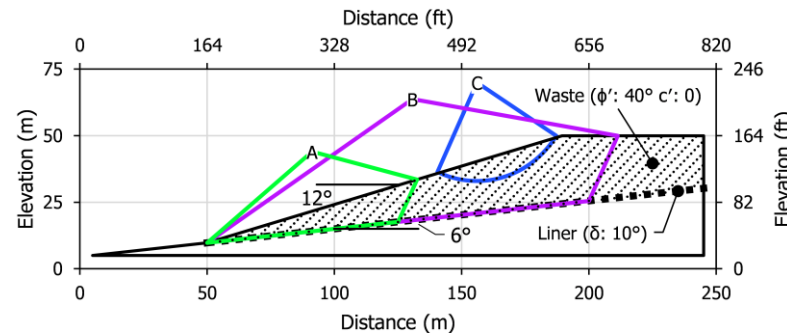
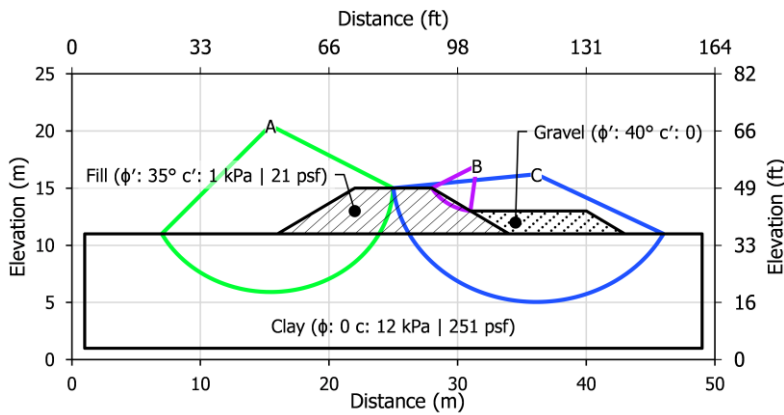
Developing and understanding tools that engineers use

“~~Students~~ *Engineers* take to gadgets and neat little mathematical procedures like ducklings to water.”

But do we have a good conceptual knowledge?

I asked some engineers to select the slip surface with the highest and lowest factor of safety.

Giving reasons was optional.

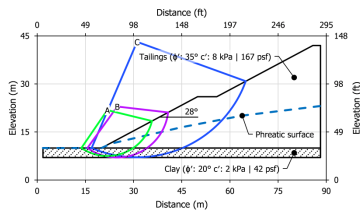
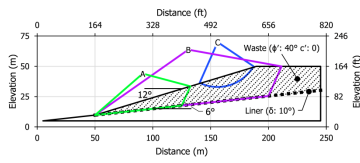
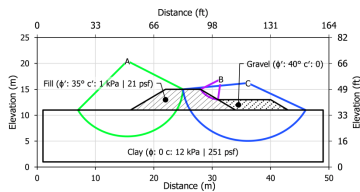


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Findings (181 participants):

- Expertise showed no correlation to performance: Likely threshold concepts.
- While 19% made at least one very wrong decision, only 1.7% made two very wrong decisions and none made three very wrong decisions.
- **Many correctly linked slope angle and frictional strength to factor of safety.**
- **Many underestimated the impact of cohesion on stability: A safe heuristic but can lead to overlooking more critical slip surfaces.**
- **Many based their decision on the heuristic that larger failing masses have a lower factor of safety: A faulty heuristic for frictional material.**

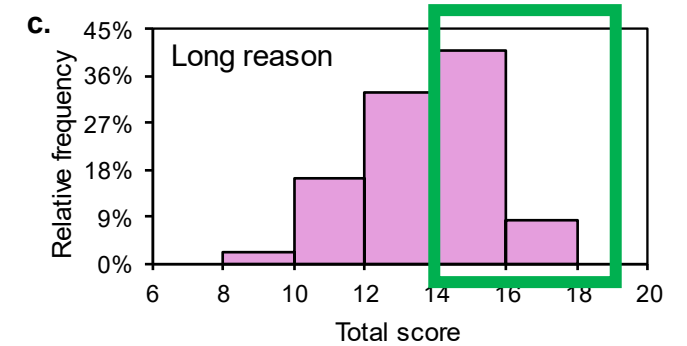
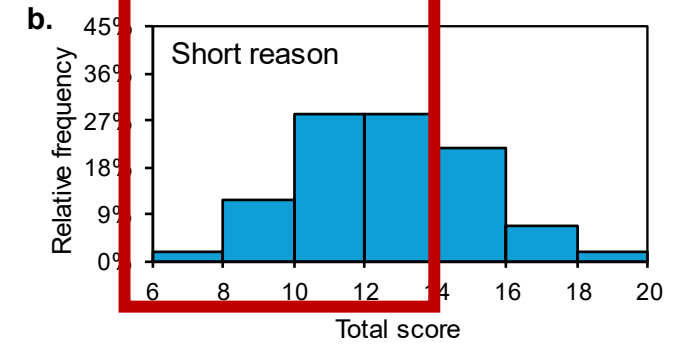
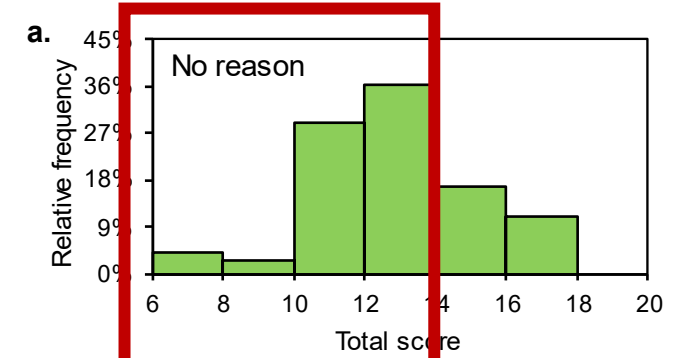
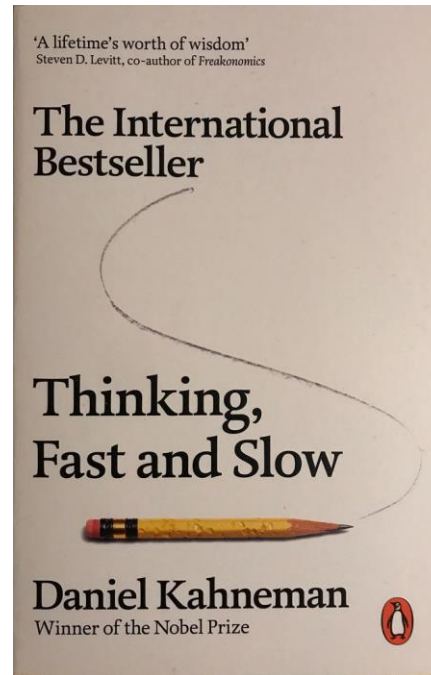
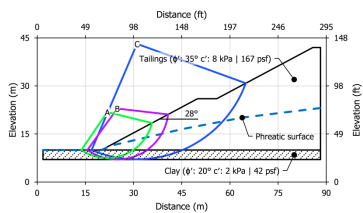
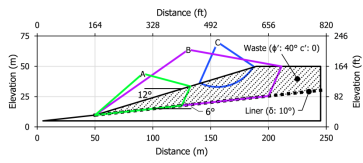
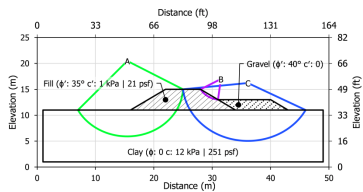


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Findings (181 participants):

- Longer reasons resulted in more correct decisions



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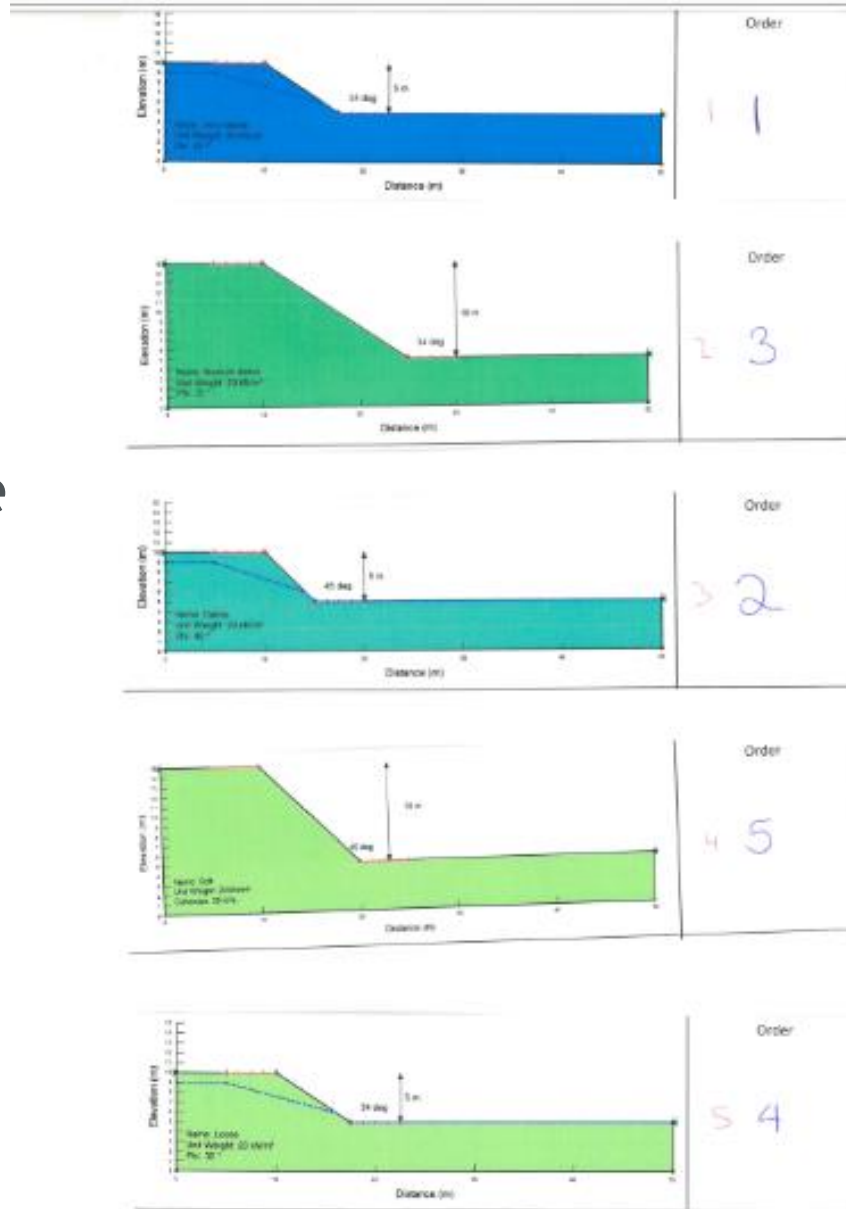
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How do we improve conceptual knowledge?



Score: 4

Slope stability intuition

Instructions

- In Groups of 4
 - Review a set of 48 slope stability analysis (learning set) and develop a set of heuristics (failable intuitive rules) to relate slope geometry, strength, and phreatic surface (water table) to the factor of safety. Heuristics can be:
 - Language based logic (i.e., a series of statements)
 - Formal symbolic logic (i.e., a series of mathematical expressions)
 - Once you have written down your heuristics (time limit = 25 minutes) you return your learning set and receive your test set.
 - Your group will have 5 minutes to order the test set from most stable (i.e., highest factor of safety) to least stable (i.e., lowest factor of safety):
 - Label each scenario from 1 to 5, with 1 being the most stable and 5 the least stable.
 - Enclose your solution in the envelope along with your heuristics.
 - The group (or groups) that are closest to the correct order will receive a prize.

Group Members:

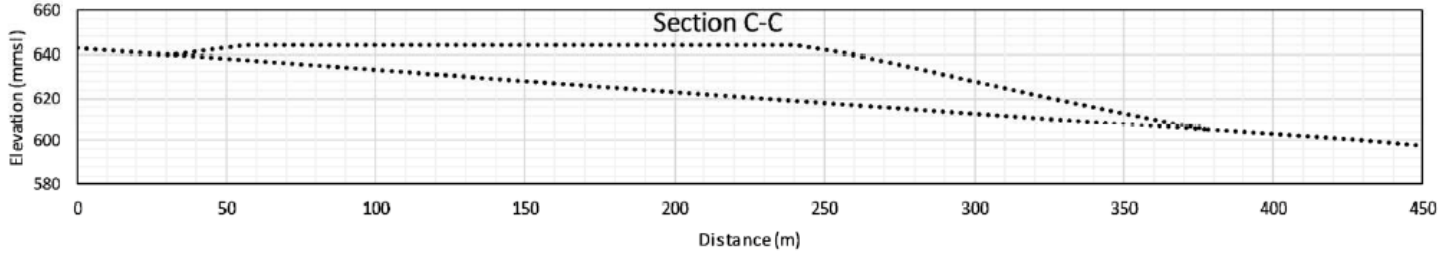
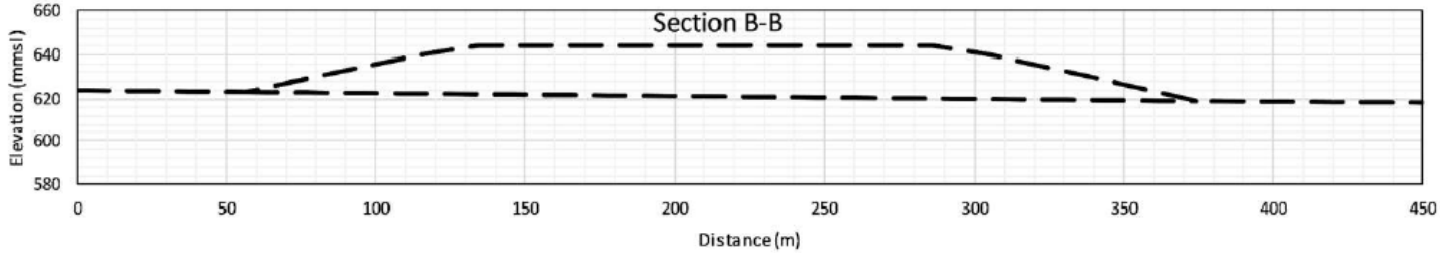
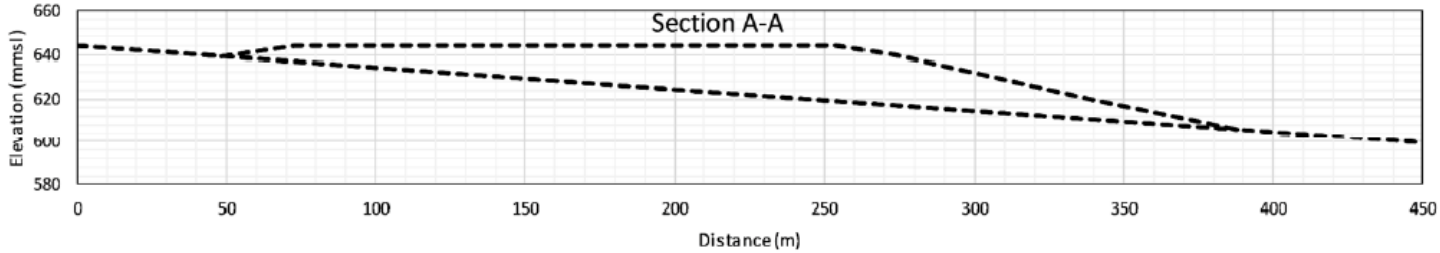
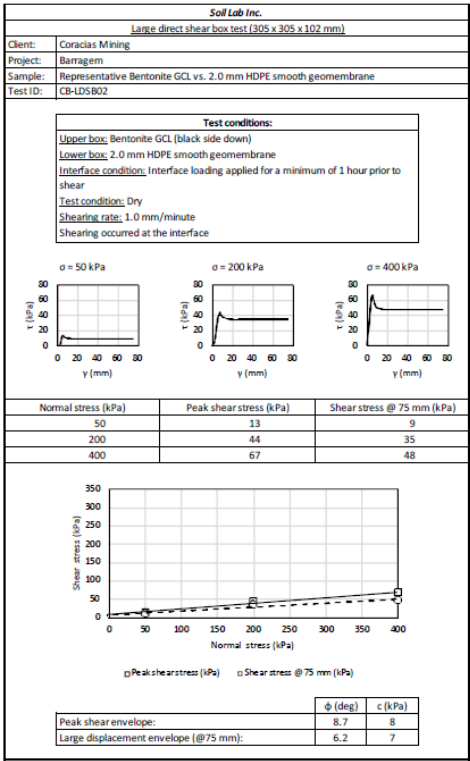
Heuristics:

Rules:

- Very loose sand - more unstable. Denser or finer material is more stable.
- Soft sand has big failure envelope
- Higher angle, ϕ is more unstable
- Higher elevation is more unstable.
- Lower cohesion is more unstable
- Higher ϕ , more stable
- A water table closer to surface is less stable
- Lower angle - bigger failure envelope
- Higher safety factor - more stable

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Asked students to design a lined waste facility

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Database of high fidelity back-analysed slope stability incidents.

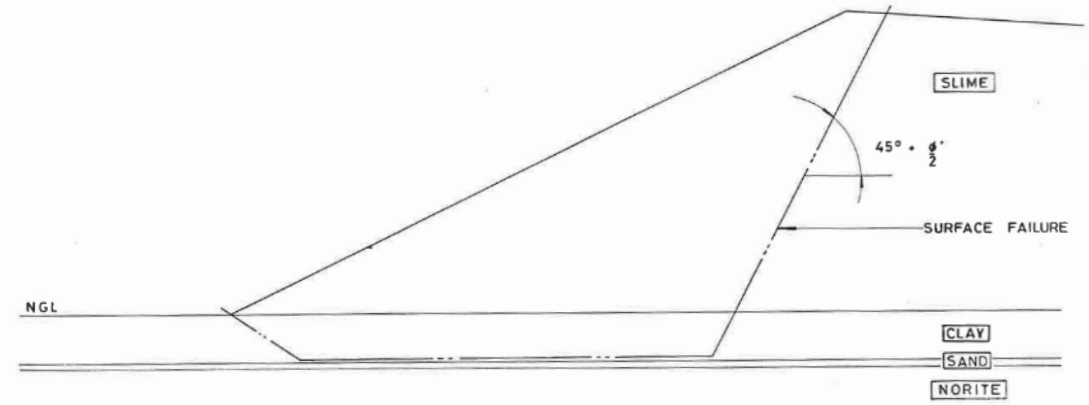
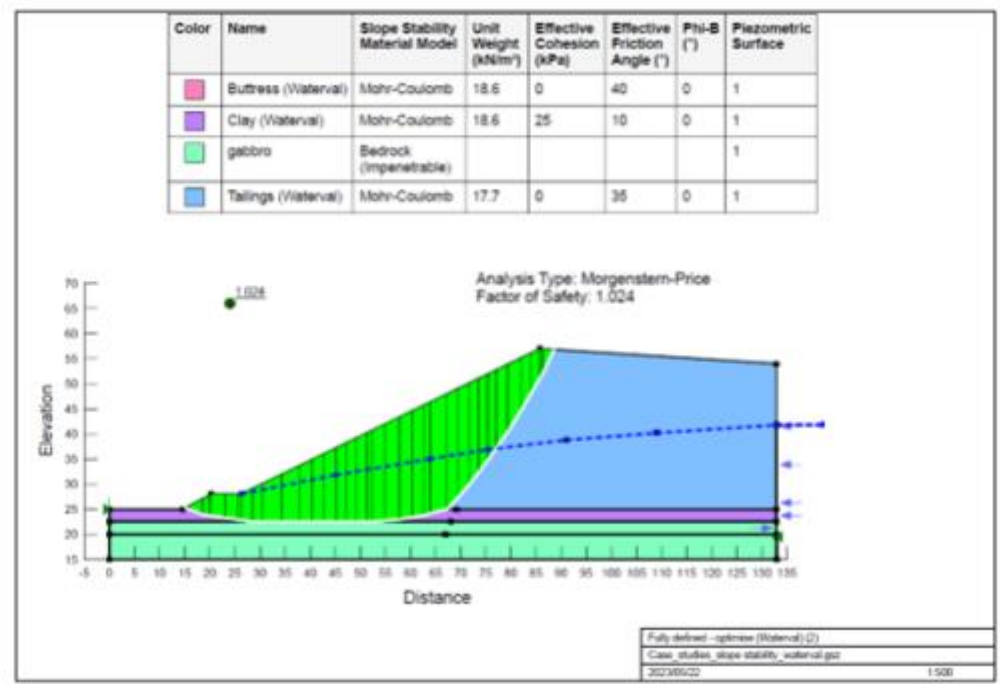


FIGURE 4
SUSPECTED FAILURE SURFACE FOR COHESIONLESS FILL ON A WEAK CLAY FOUNDATION

DAM	HOLE/SAMPLE No.	SOAKED DRAINED CONSOLIDATED SHEAR BOX ON UNDISTURBED SAMPLES				SOAKED DRAINED CONSOLIDATED SHEAR BOX ON REMOULDED SAMPLES				NOTES
		PEAK		RESIDUAL		PEAK		RESIDUAL		
		c'	φ'	c'	φ'	c'	φ'	c'	φ'	
KLIP-FONTEIN	2/6,7*	43	16,5	37,5	6,0	25	13	16	8,3	
WATERVAL	22/22**	35	12,5	33	7	30	14	17	9	** RING SAMPLE

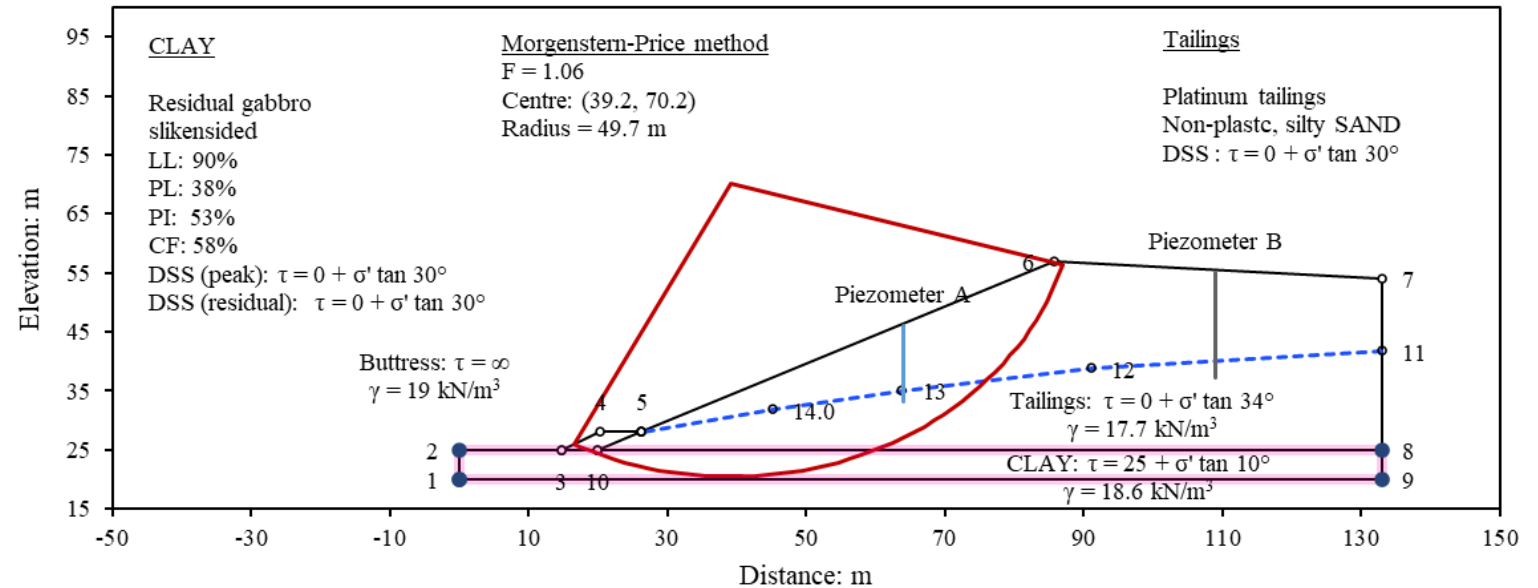
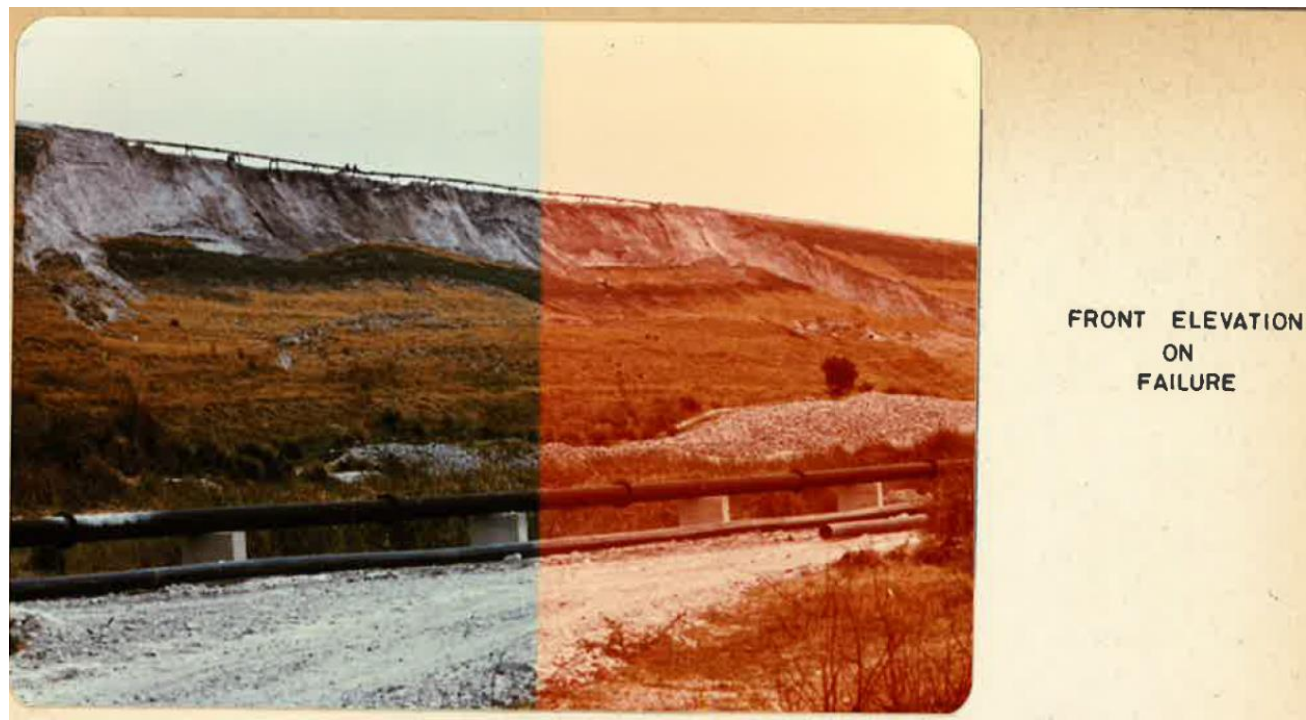
TABLE 7.1.2. TABLE OF CONSOLIDATED SOAKED DRAINED SHEAR BOX TEST RESULTS ON FOUNDATION SOILS



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How geology put a South African city at risk of landslides

Published: April 21, 2022 3:54pm SAST • Updated: January 5, 2023 9:01am SAST



This aerial view shows the destruction at Umhloti beach north of Durban. Landslides and floods wreaked havoc. Marco Longari/AFP via Getty Images

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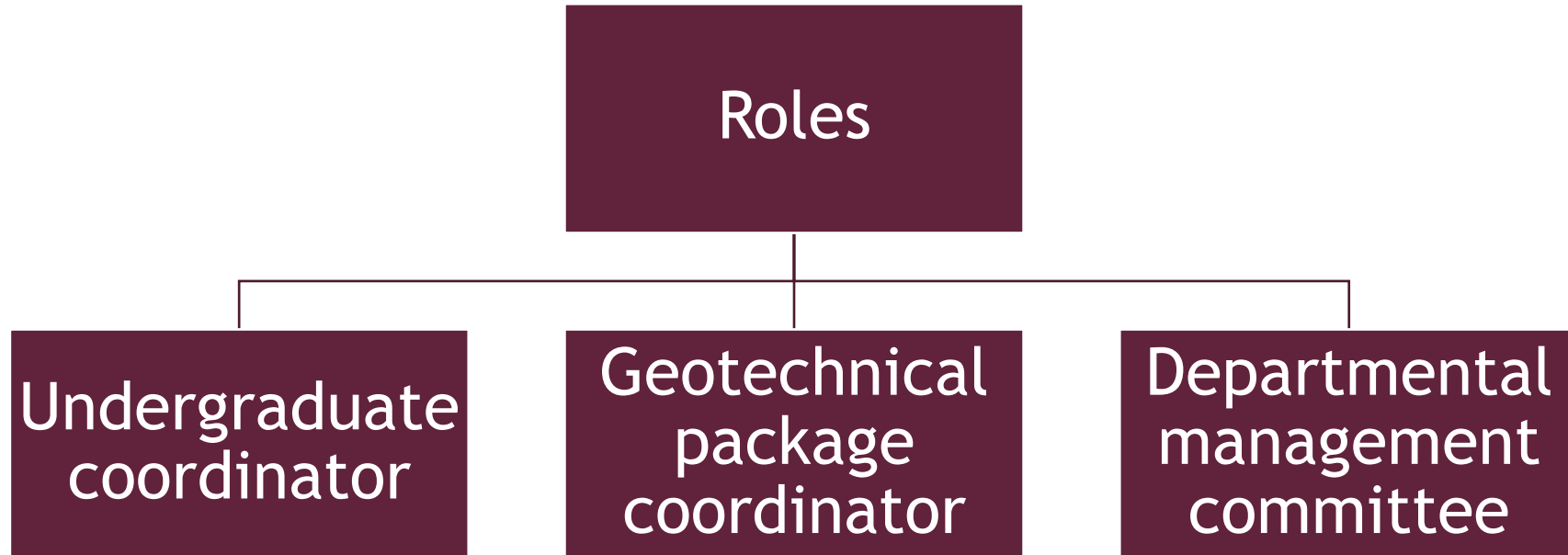
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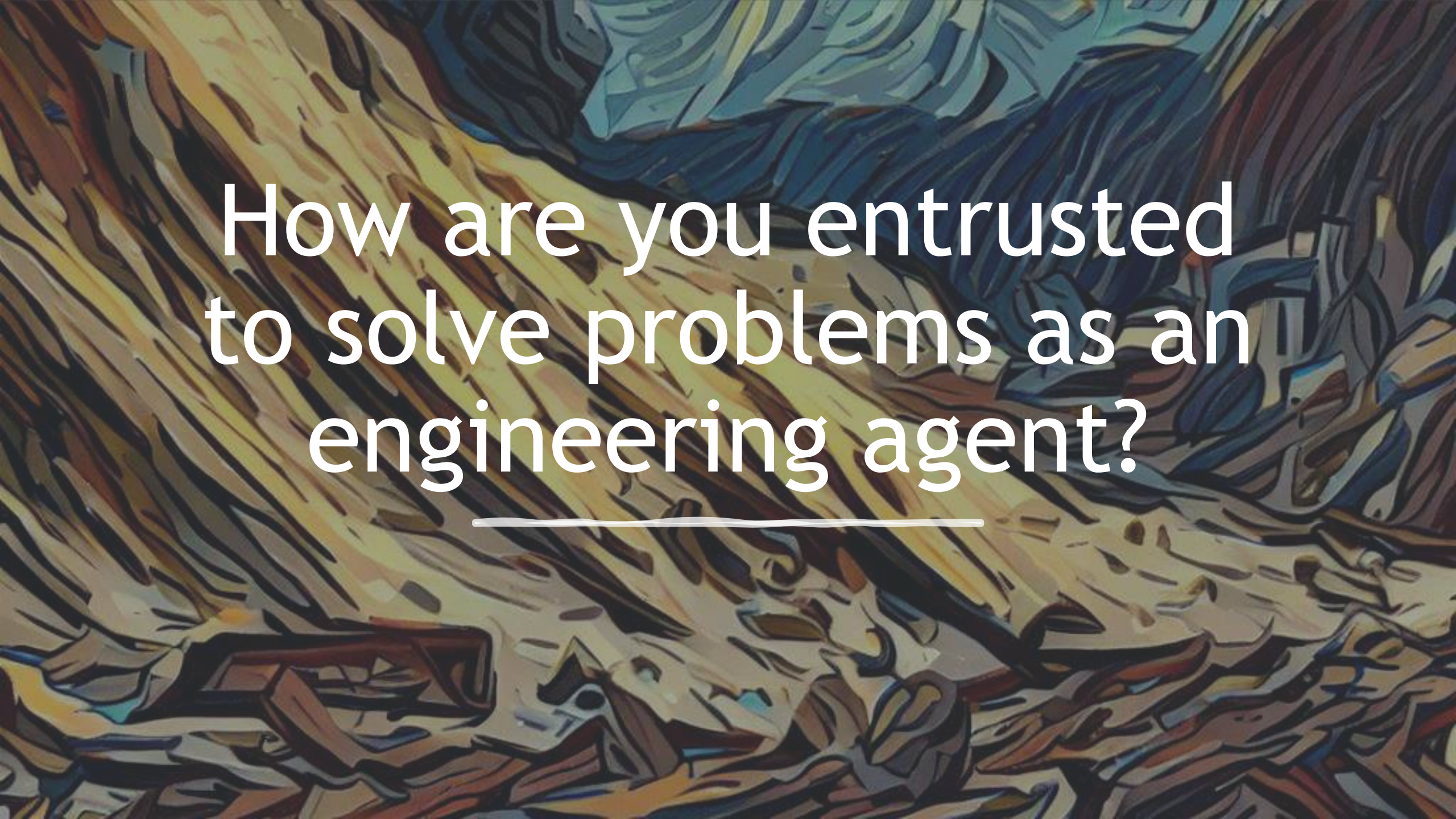
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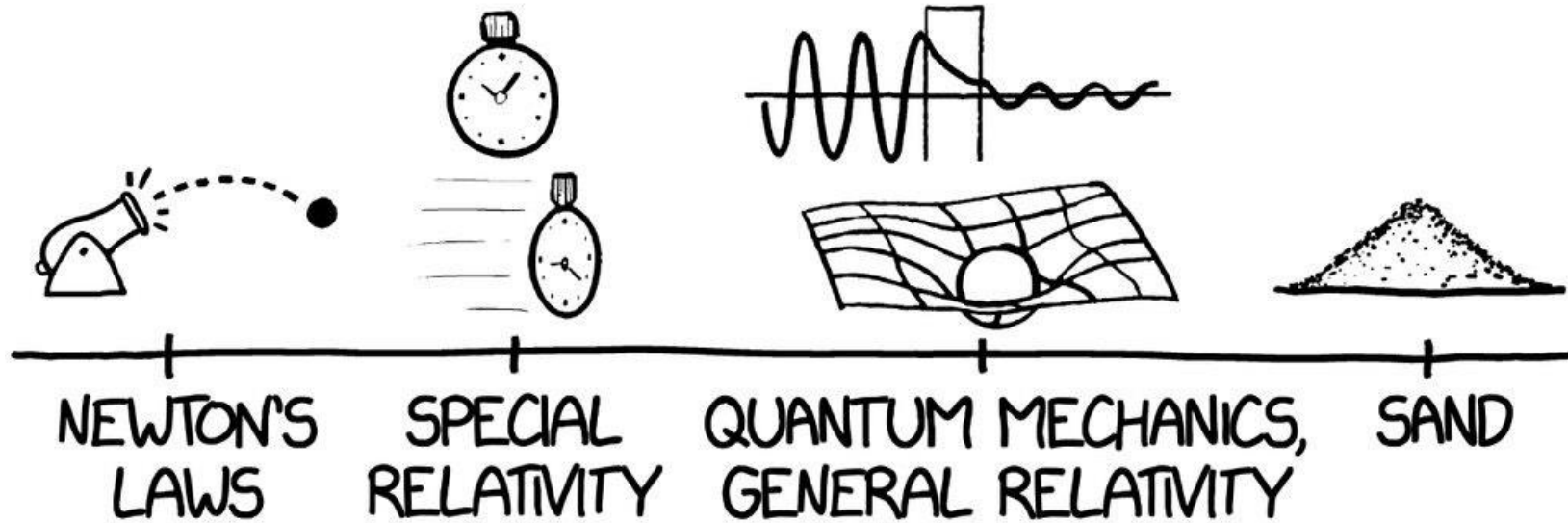




How are you entrusted
to solve problems as an
engineering agent?

Questions?

AREAS OF PHYSICS BY DIFFICULTY
HARDER →



Thank you
Enkosi
Dankie