What is Failure? and why do failures occur?

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What is Failure?

- unplanned outcome.
- results in loss.

Inconvenient

Loss of life

Good design

Fit for purpose?

Who decides?

Failure to learn from failure.
What is Failure?

• collapse.
• excessive movement.
• overconservative.
• too little movement.

Abbey Sewer Tunnel

Shield and screw conveyor clogged with plastic clay.

Noble Al White

Erosion failure.

Excavation and compaction.

Common Mistakes

• unforeseen ground conditions.
• wrong soil mechanics.
• incorrect analyses.
• poor workmanship.

Understand the Geology
Geotechnical Model

- strata in their locations.
- groundwater.
- material design parameters.
- consequences of the works.

Must be geologically possible: no divine intervention.

Gutters not emptying was initial complaint...

.... then the bath would not empty fully.

Abbey Sewer Tunnel

Unforeseeable or inadequate?

- Jersey: clearly inadequate.
- Abbey Sewer: difficult to foresee.
1. Sands are frictional and clays are cohesive.
2. Landslides occur after heavy rain so water lubricates soil.

Both statements are incorrect.

Kings Lynn Cofferdam

Client had sheet piles from previous job.
One borehole 1km away.
UU test → $c_u$ CU test → $\phi'$

Design based on $\tau = c_u + s \tan \phi'$

Parameters for design: strength.

- Drained or undrained: $\phi'$ or $s_u$?
- Peak, ultimate or residual?

Shear stress

Residual

Ultimate = CS

Distortion

Choice of Strength for Design

Very large movement: residual
First time failures: ultimate = CS
Small movement: peak + LF

Stability of Slopes.

Laboratory tests
**Basic Analyses.**
- \( i = \frac{1}{2} \phi \)
- \( q = (2 + \pi)c_u \)
- \( K_a = \tan^2(45^\circ - \frac{1}{2} \phi) \)

**Principles of Design.**
- Slopes: \( \phi_c \); worst \( u \); \( F_s = 1 \)
- Foundations: Peak strength; \( F_s = 3 \)

**Common Mistakes**
- unforeseen ground conditions.
- wrong soil mechanics.
- incorrect analyses.
- poor workmanship.

**Wrong Analysis**

6 houses and gardens
Costs were £550K for slope and £650K for damage.

Common Mistakes

- unforeseen ground conditions.
- wrong soil mechanics.
- incorrect analyses.
- poor workmanship.

Competence.

- Education.
- Training.
- Experience.
Test of Competence.
How to avoid taking the blame

- Precedent: it is always done like this.
- Adherence to codes.
- Support from The Expert

Ground Engineering in Practice

- 2/3 done by non-geotechnical engineers (i.e., people without special education and training in geotechnical engineering).
- How did they acquire their competence?

Education: school and university

Basic principles
Training: teaching on the job
How to get the job done.
Experience: doing lots of it
Making mistakes.

Education: Basic Principles.

Geology
- \( i = \phi' \)
- \( q = (2 + \pi)k_{cr} \)
- \( K_s = \tan^2(45^\circ + \frac{1}{2}\phi') \)

Slopes: \( \epsilon_s' \); worst u; \( F_s = 1 \)
Foundations: Peak strength; \( F_s = 3 \)

Training.

- Use of codes, standards and programs.
- Business: how to get the job done.
- Difficult to do effectively in the University.

Who teaches the teachers?
- Their teachers.

Who trains the trainers?
- Their trainers.
What to do?

- Registration: a licence to do things.
- Arbitration: sort it out afterwards.

Other Thoughts.

New methods of procurement (e.g., design and construct) will require greater innovation. There is more opportunity to make mistakes.

It is not just big projects. Compare 10^5 house foundations with 10^6 Dublin Port Tunnels.

What is Failure?

Unplanned event: not just instability.
Results in loss: to whom?

Why do failures occur?

Mostly lack of competence.
Sometimes pushing the boundaries.

Questions?

Are people doing ground engineering competent?

Should ground engineers be registered?

Should supervising engineers have compulsory CPD?