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Designing for a Changing World:
The Role of Data & Artificial Intelligence

Introducing Arup

We are a global collective of designers, experts and consultants dedicated to sustainable development. We use technology, imagination and rigor to shape a better world.

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Insurance Claims Around the World[1]

- Frequency of natural disasters has increased builders' risk claims by **14%**
- Design errors are the most frequent cause of professional liability claims, accounting for **62% of all claims** filed by construction firms in 2023
- Claims related to **new green building projects** have risen by **7%** in 2023, as more **complex environmental standards lead to frequent** disputes over project quality and timelines

[1]Construction Insurance Industry Statistics 2025 • CoinLaw

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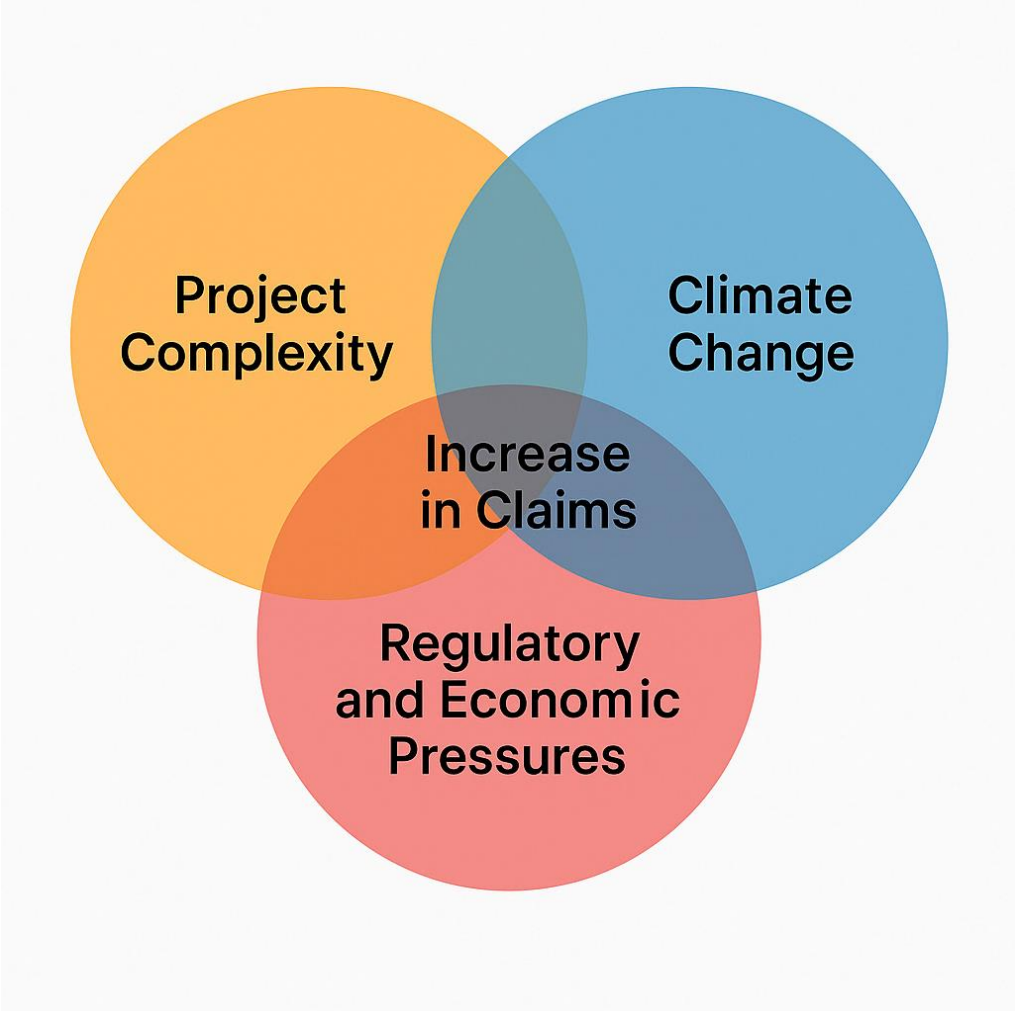
AEC Insurance Claims: Major Contributing Factors



Tacoma Narrows Bridge Catastrophic Failure (1940)

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Failure Cause: Aeroelastic flutter underestimated in design

Data and AI Solutions:

- ✓ Simulation tools with real-world wind data
- ✓ AI-Powered stress analysis and structural resonance prediction

Case Study: Berlin AquaDom (2022)

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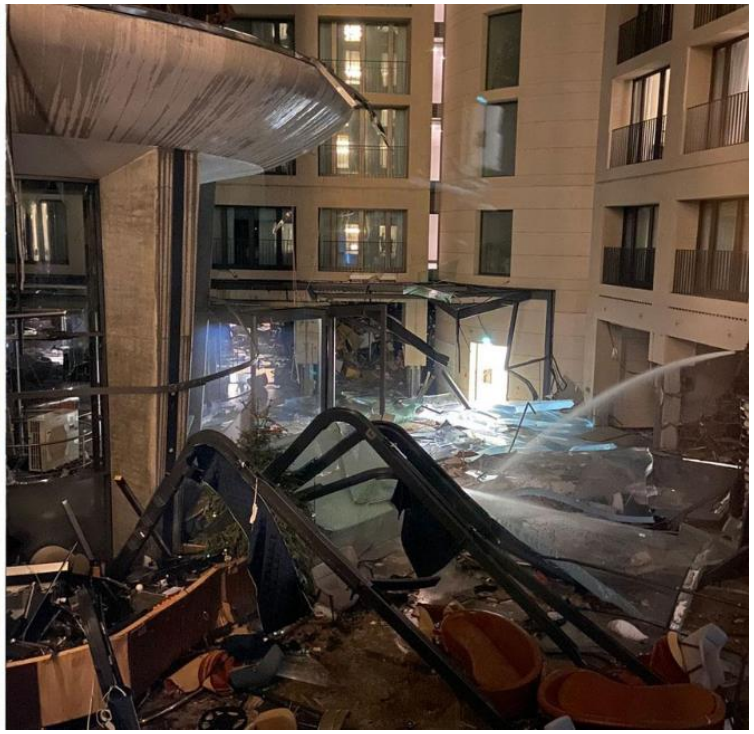
Failure Cause: Structural Weakness in Acrylic Cylinder

Data and AI Solutions:

- Predicative Maintenance Using AI
- Structural Health Monitoring
- Environmental Data Correlation
- Automated Risk Assessment



Key Technologies Driving Change

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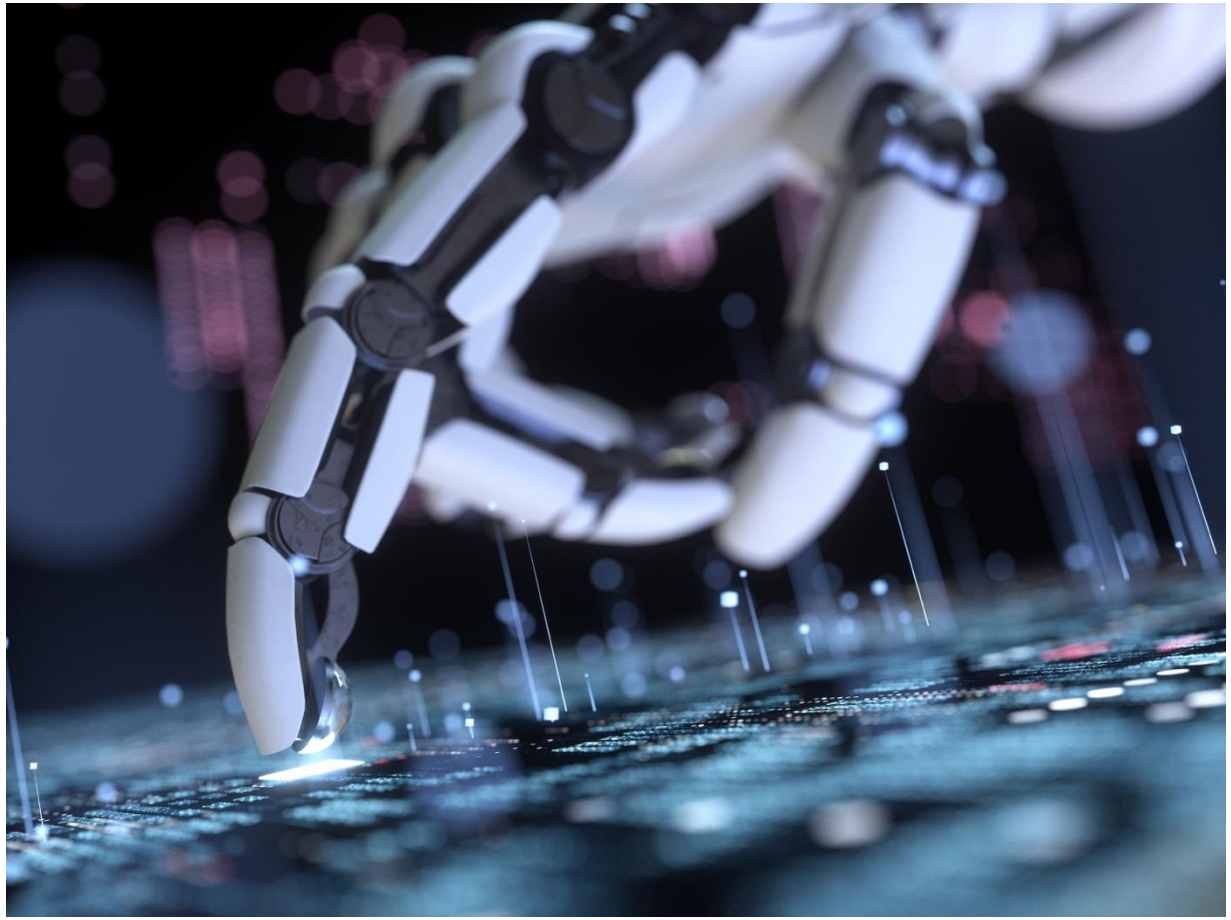
- Digital Twins
- Generative Design (e.g., Autodesk Dreamcatcher)
- Predictive Maintenance Systems
- Neural Networks for Pattern Recognition in Material Behavior



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It Begins with the Data……..

……Start There!

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Arup Use Case: Project XYZ Noise Barrier Testing

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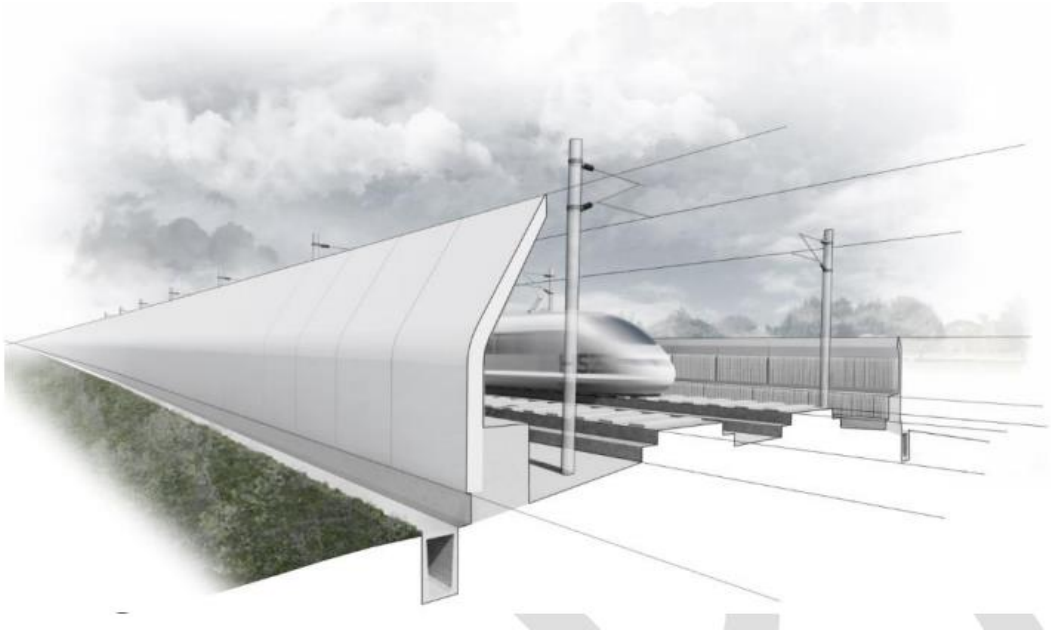
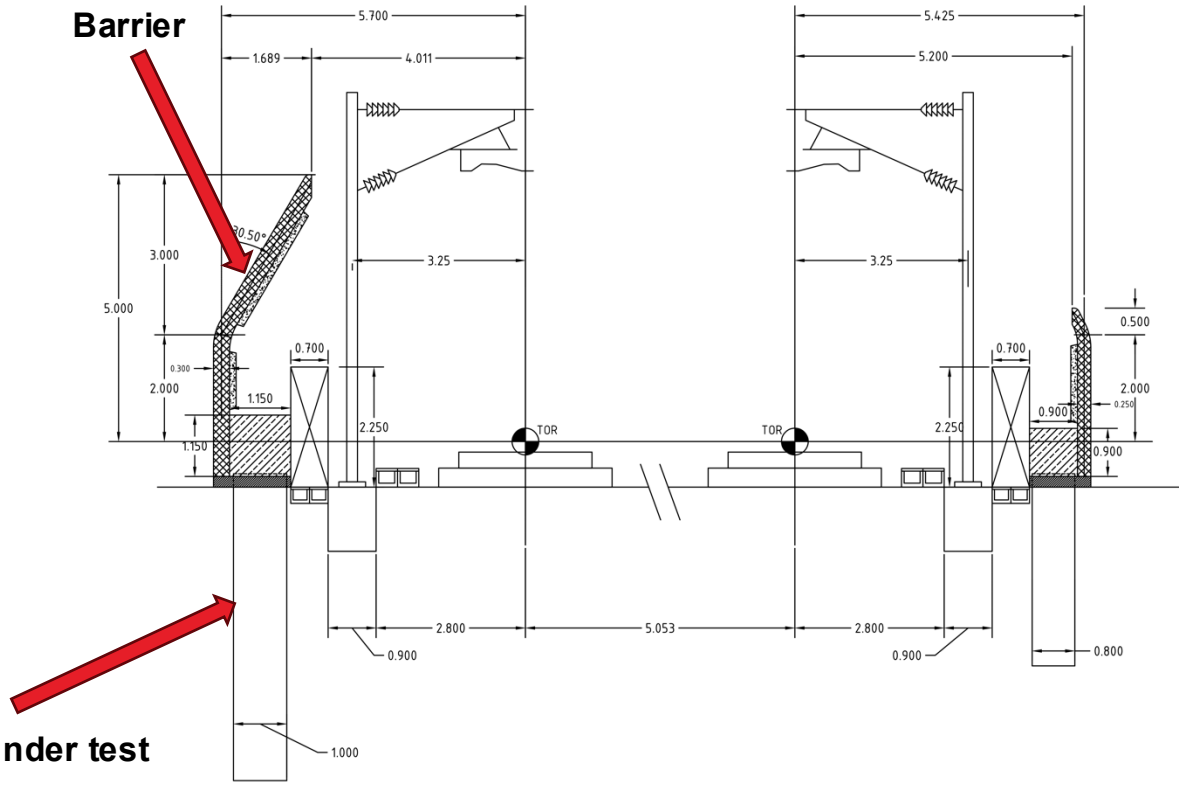
'Cranked' Noise Barriers in Open Urban Area

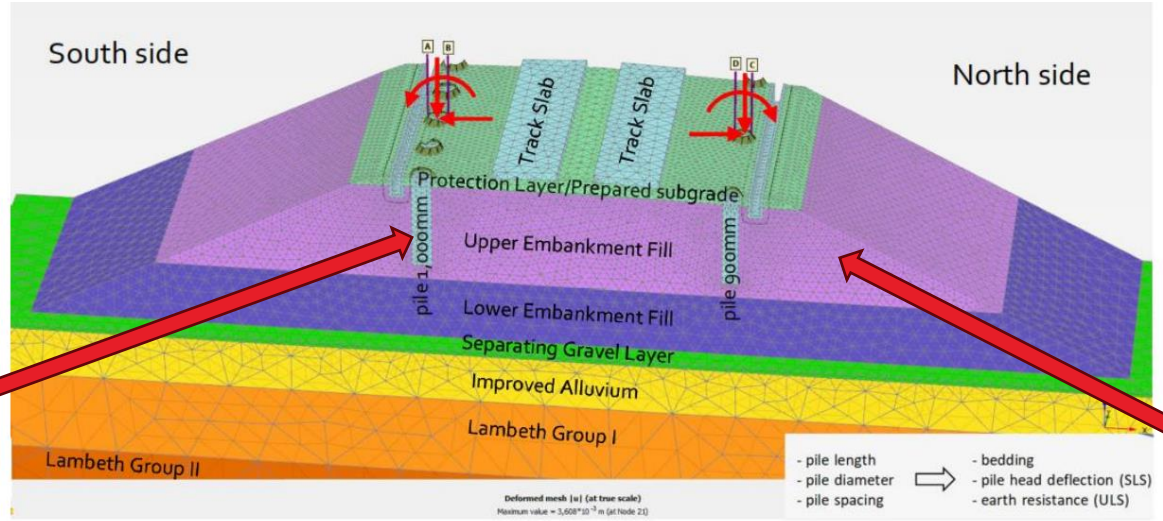
Design life of 200-mph train every 10 minutes for 120 years





Test site and geological context

Test to ensure design will withstand expected forces on fabricated embankment



Pile foundations under test

Built up embankment hosting foundations

Pile test site

Data in its Context

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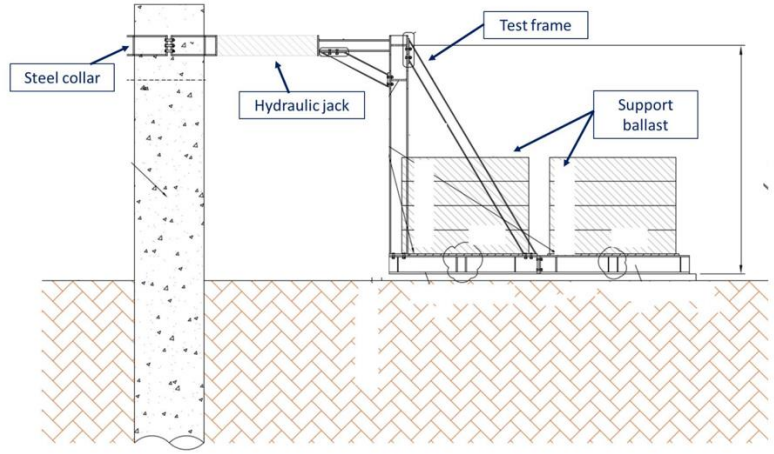
Pile 1

Pile 2



Data cabin

Reaction Frame

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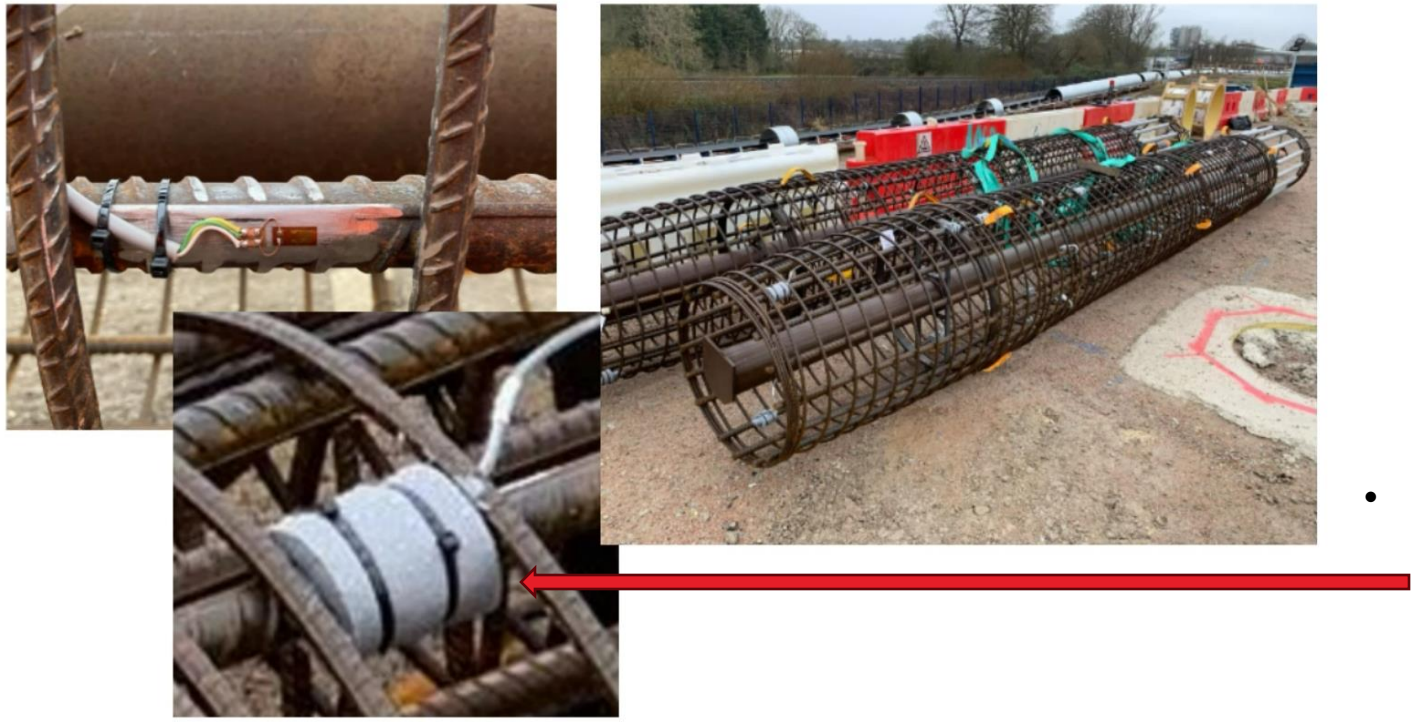
Inside the pile!

Sample construction – Pile reinforcement & strain gauge installation



- **Pile reinforcement**
  - **820 diameter cage**
  - **B25 diameter main bar**
  - **B16 links**
  - **160mm steel casing for inclinometer**
  - **TW extension for weld lifting band**
  - **Band stiffeners connected to main bars with bulldog clips**

- **Strain gauges**
  - **Electrical strain gage - linear**
  - **M series 1-LM11-3-350**
  - **10^7 cycles at 2000 micrometres per metre**

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Data Source Overview

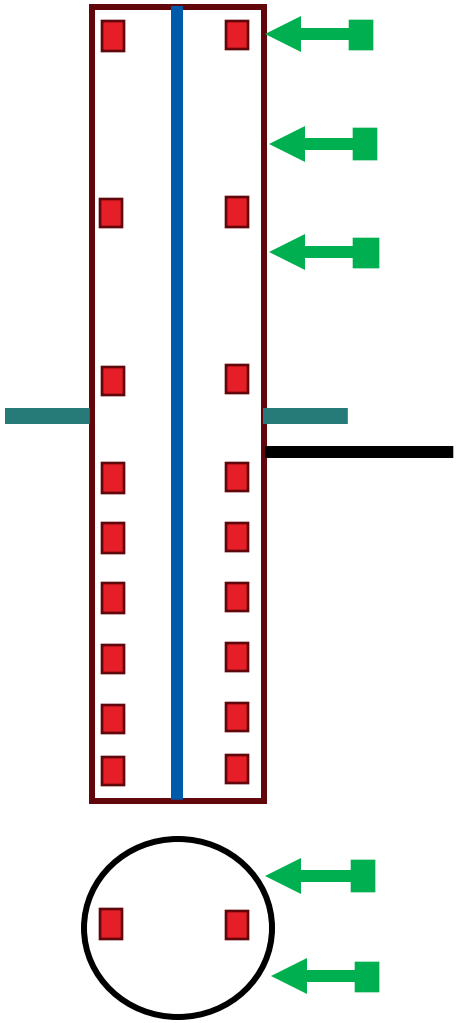
Two types of data

Action

- Actuator data
- Application of force, up to 96KN, 1-second cycles

Reaction

- Multiple sensors
- 6 Displacement (external)
- 18 Strain (internal)



Raw Data Complexity

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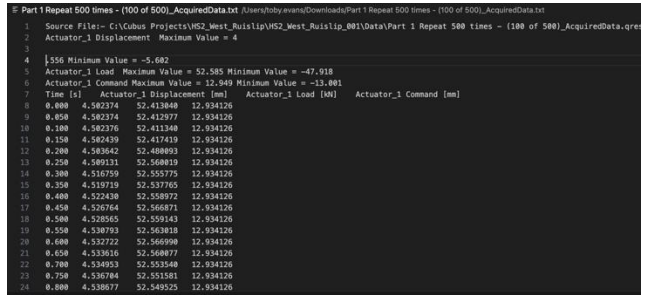
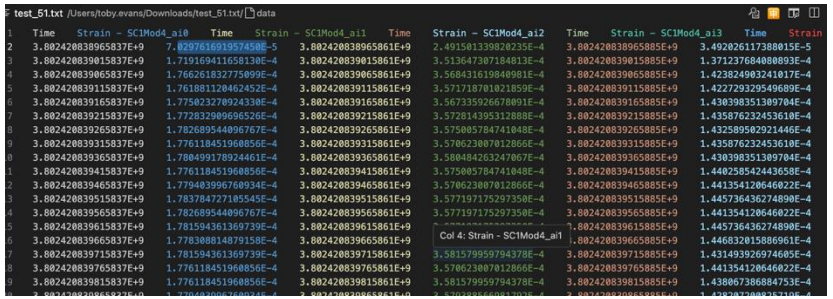
Significant pre-processing required before analysis



Action data

- Non-standard CSV format
- Data in 20-second increments from 0.000, but not saying when “0” was



Reaction data:

- Structure changed between tests (became more compact)
- Time is recorded as seconds since 1st Jan 1904 (in scientific format)
- ‘Wide’ data in columns – requires ‘melting’ (stacking) to compare

Data Processing & Modelling

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500 rows p/second
30k p/minute
1.8m p/hour
43M p/day
302M p/week

Client XYZ Environment

Action - Actuator

3k file, 1.6GB

Reaction - Instruments

270 files, 70GB

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Match file times

Action (72M)

Strain (900M)

Split

Convert & clean

Displacement (400M)

databricks

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Project XYZ Lessons on Data and AI Integration

- ✓ All data comes from people in a context – understand the Data Generation Point
- ✓ Optimize the collection, flow and completeness of data before analysis. **Use AI to Optimize or Improve Quality of Data!**
- ✓ Automate everything you can and iterate the design
- ✓ SaaS Cloud technology enables scalable large data processing and application of Machine Learning
- ✓ **Experience feeding into Industry Research project on modernizing 'Observational Method'**

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Conclusion….

Client Value = Project Overheard plus Expertise

- Leveraging “Big” Data and AI for engineering and design is no longer optional. It helps to prevent catastrophic failures and enables groundbreaking designs

- Engineering’s Future Lies in Data-Driven Innovation

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