

WP3.1

Are hydraulic pressure vessels subject to fatigue and crack propagation?

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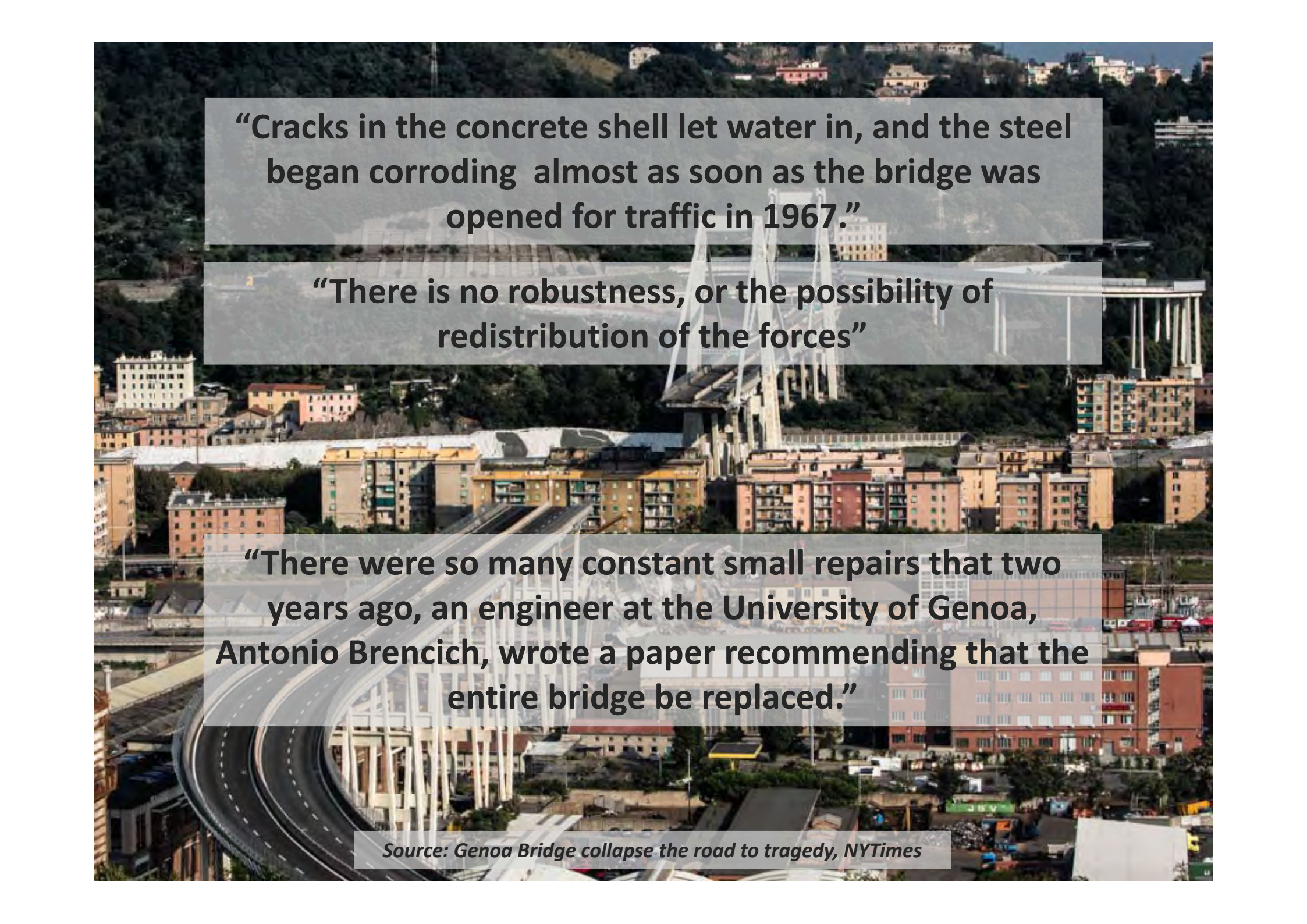
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Context



Materials are ageing and it can have a serious impact on infrastructures...

An aerial photograph of the Genoa Bridge, a suspension bridge with white towers and cables, spanning across a bay. The bridge is surrounded by a dense urban area with multi-story buildings and a hillside with more houses in the background. The sky is clear and blue.

“Cracks in the concrete shell let water in, and the steel began corroding almost as soon as the bridge was opened for traffic in 1967.”

“There is no robustness, or the possibility of redistribution of the forces”

“There were so many constant small repairs that two years ago, an engineer at the University of Genoa, Antonio Brencich, wrote a paper recommending that the entire bridge be replaced.”

Source: Genoa Bridge collapse the road to tragedy, NYTimes

Ageing and Assets Management

Managing Hydropower Assets

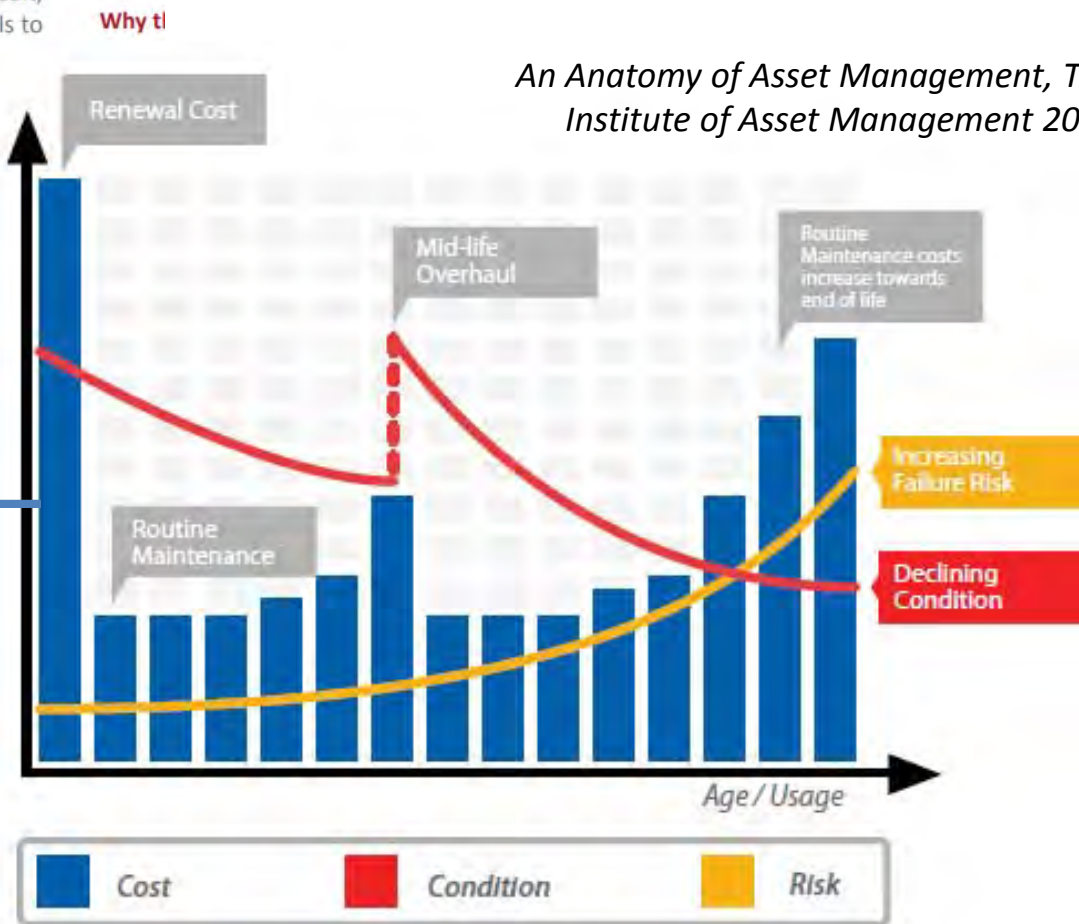
ISO 55000 for Performance-Based Maintenance

Hydropower is becoming less price-competitive. As a result, hydropower infrastructures need advanced management tools to make sure that the production assets remain a reliable : added value for shareholders. The deployment of : management model based on the ISO 55000 st combined with the performance-based maintenance optimize the lifecycle of hydropower infrastructure ensuring the people and equipment safety.

Nicolas Rouge, Olivier Bernard

Bulletin electrosuisse 2/2016

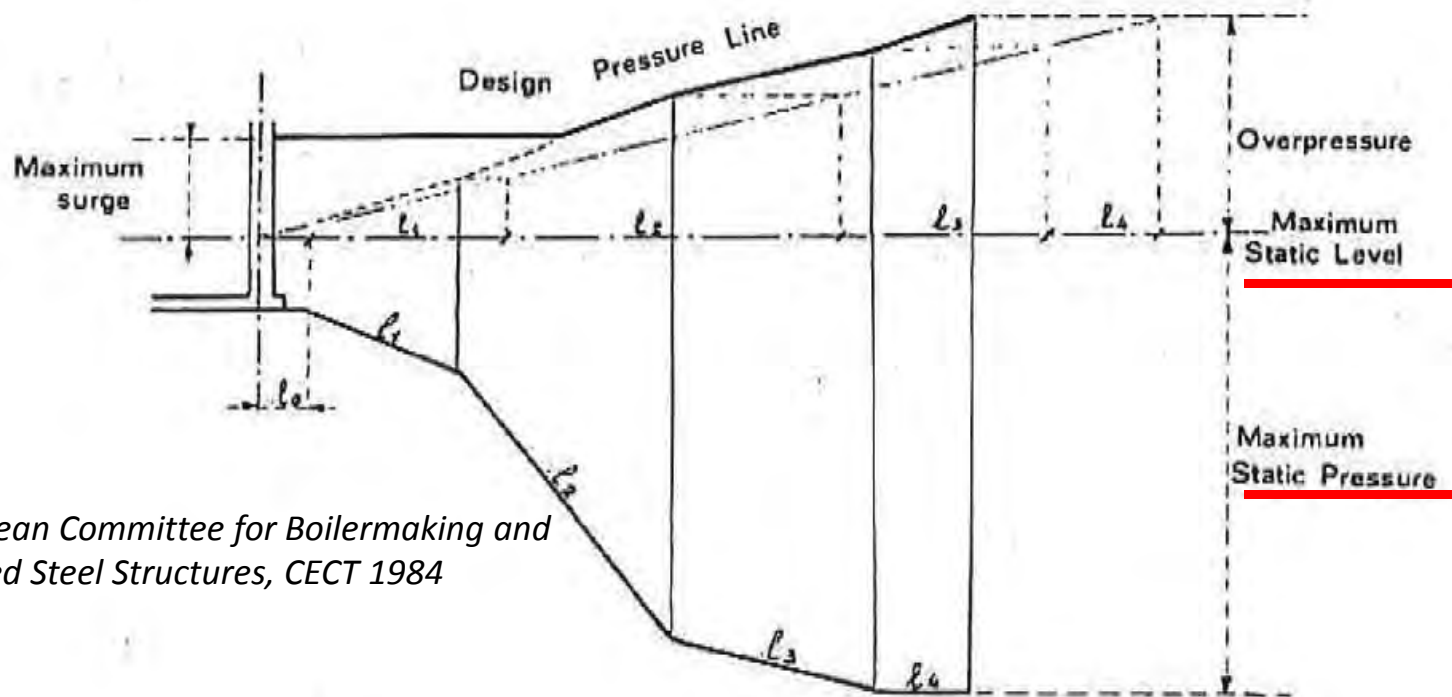
30 billions of CHF
2010-2050*



An Anatomy of Asset Management, The Institute of Asset Management 2012

*Swiss Federal Council estimation <https://www.parlament.ch/fr/ratsbetrieb/suche-curia-vista/geschaeft?AffairId=20143501>

Pressure vessels calculation



European Committee for Boilermaking and Kindred Steel Structures, CECT 1984

→ Most of the existing pipelines are not designed according to pressure fluctuations

BUT Fatigue is yet implemented in design codes such as EN 13445 and CODETI.

Ageing laws

They are function of the status of component with the time.



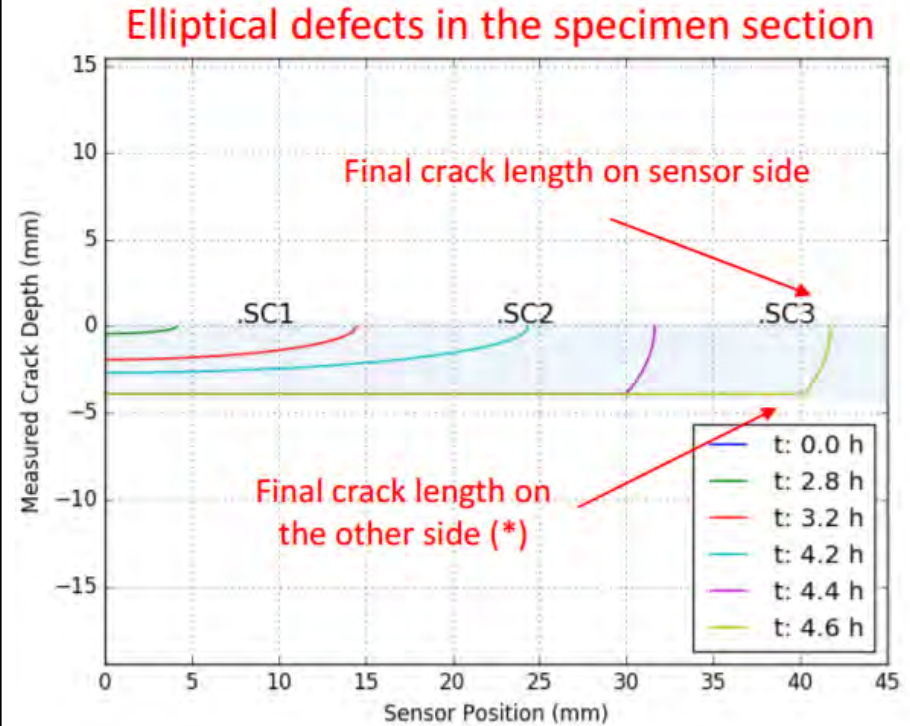
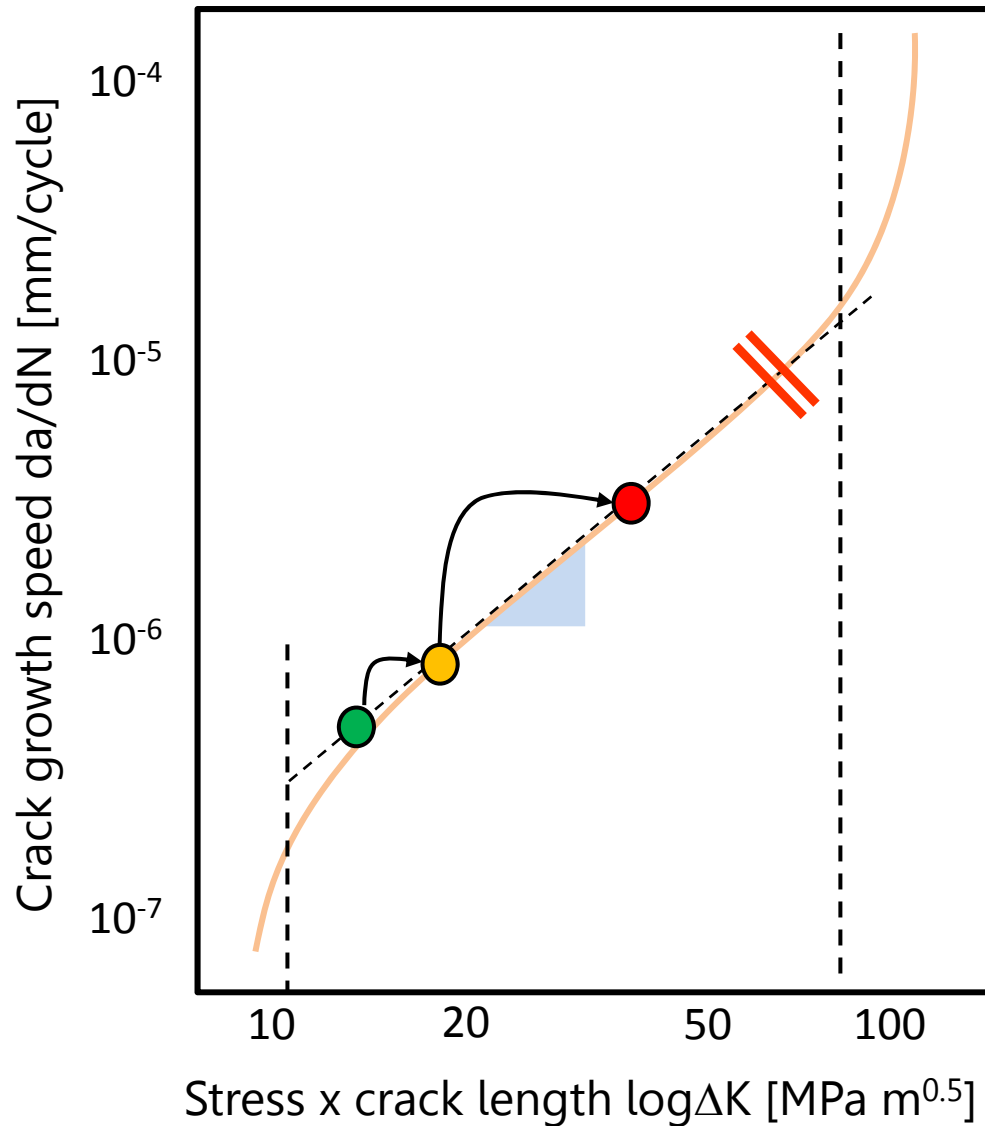
Fatigue – Wohler law

Maximum number of cycles for a given pressure amplitude (or a set of amplitudes).

Crack growth propagation – Paris law

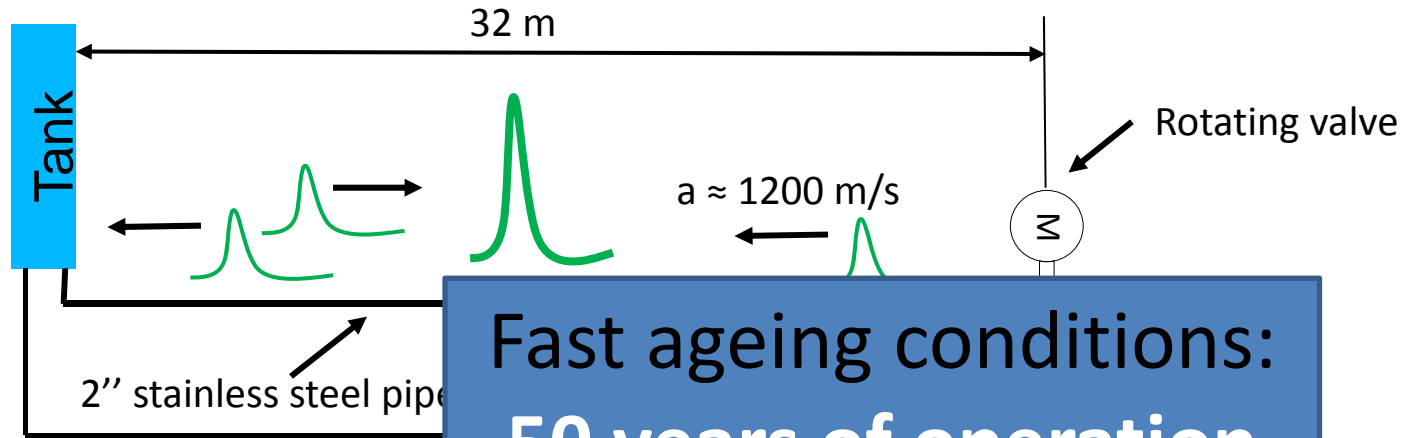
Time until a given crack reaches its critical size under known sollicitations.

Crack growth monitoring



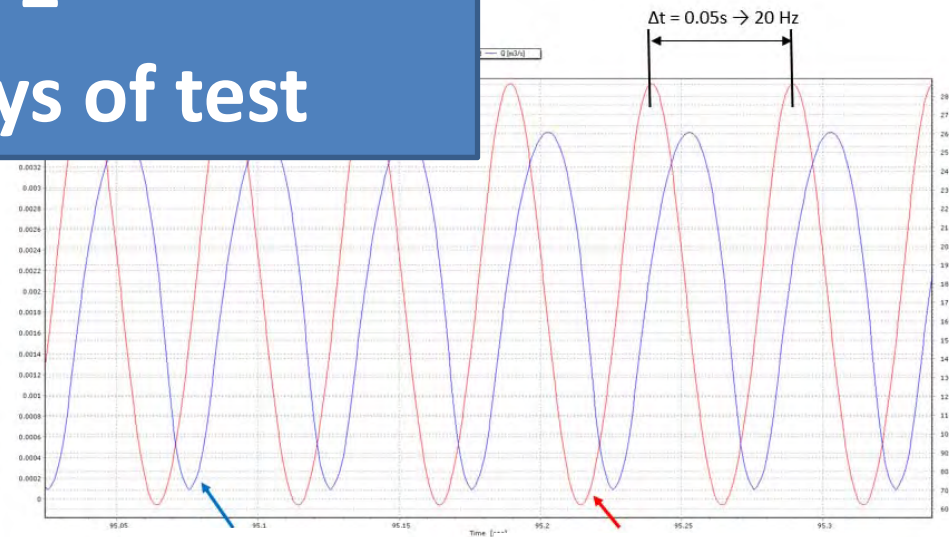
Eddy current sensors are capable of monitoring crack growth during service.

Operating principle of the test rig



**Fast ageing conditions:
50 years of operation
=
1-2 days of test**

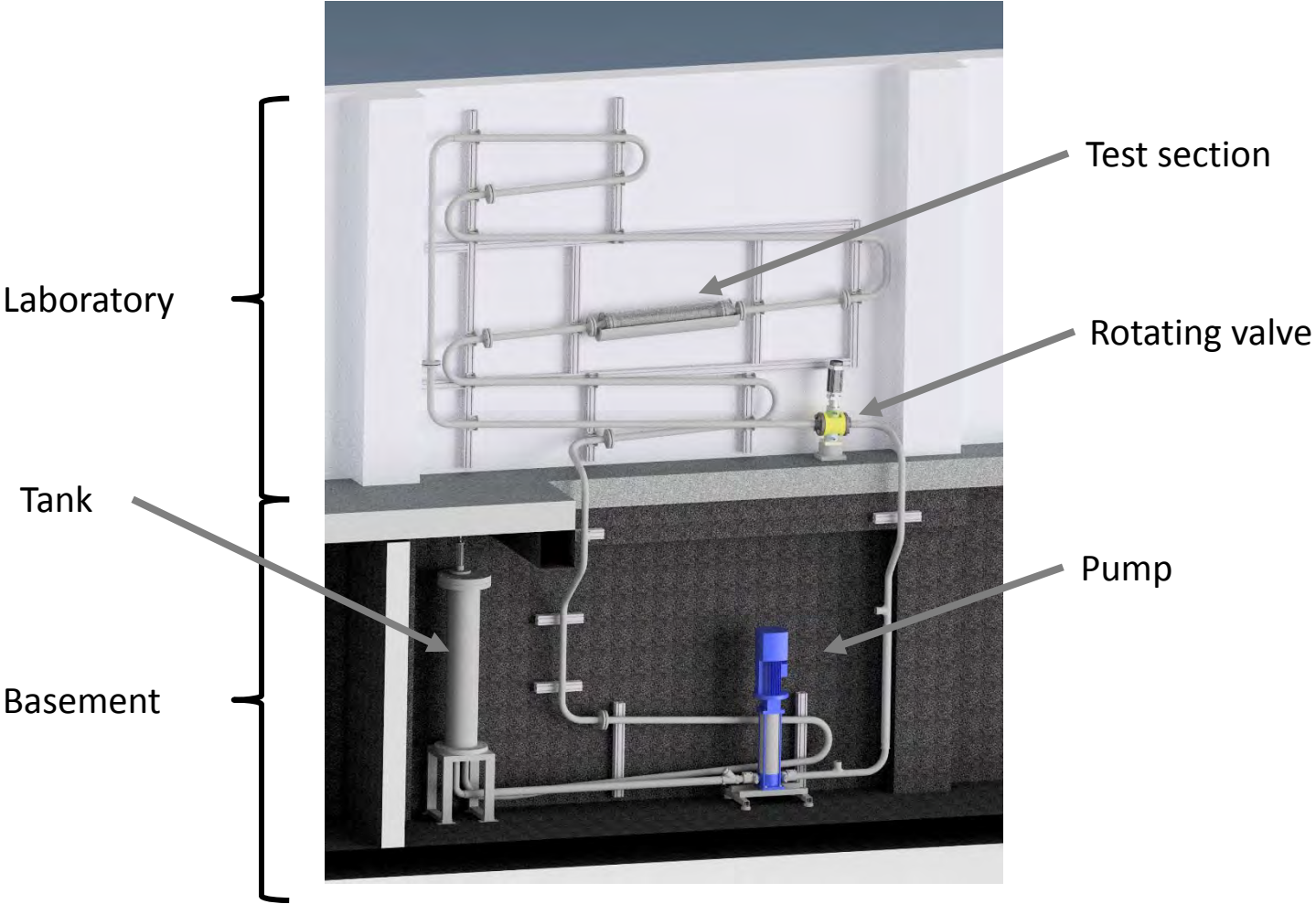
It works as an water-hydraulic hammer test, where the reflection properties of overpressure induced by periodic water-hammers. The hydraulic designed was simulated with Simsen and the help of Power Vision Engineering.



Valve flow

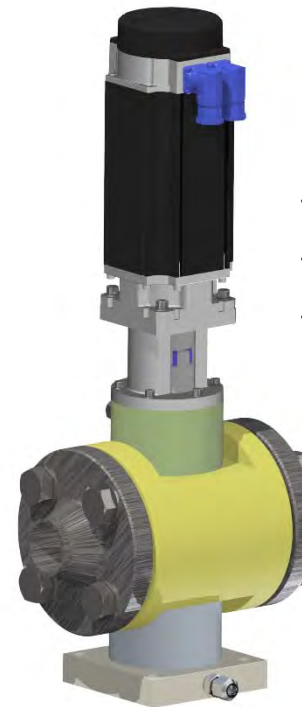
Pressure in the section

Overview of the test rig



Rotating pump

The rotating valve is a motorised cylindrical ball valve and permit the periodic obstruction of the flow as well as a single-shot closure. It was designed and constructed at HESSO-Valais with the help of LMH EPFL.



- **PN 100**
- **2 inch diameter**
- **Up to 1500 rpm or 25 Hz**

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The test rig should be operating in December...

Benefits of the in lab test rig

Prototype system

- of the fatigue monitoring (accumulation of damages due to pressure oscillations)
- of the crack growth monitoring (in water, in real time, with real cracks)

Study of the ageing laws in real cases

TRL6

Benefits for assets management

- Better ageing law → better risk prediction



Thank you for your attention