Pressurized Structural Member Damage Detection

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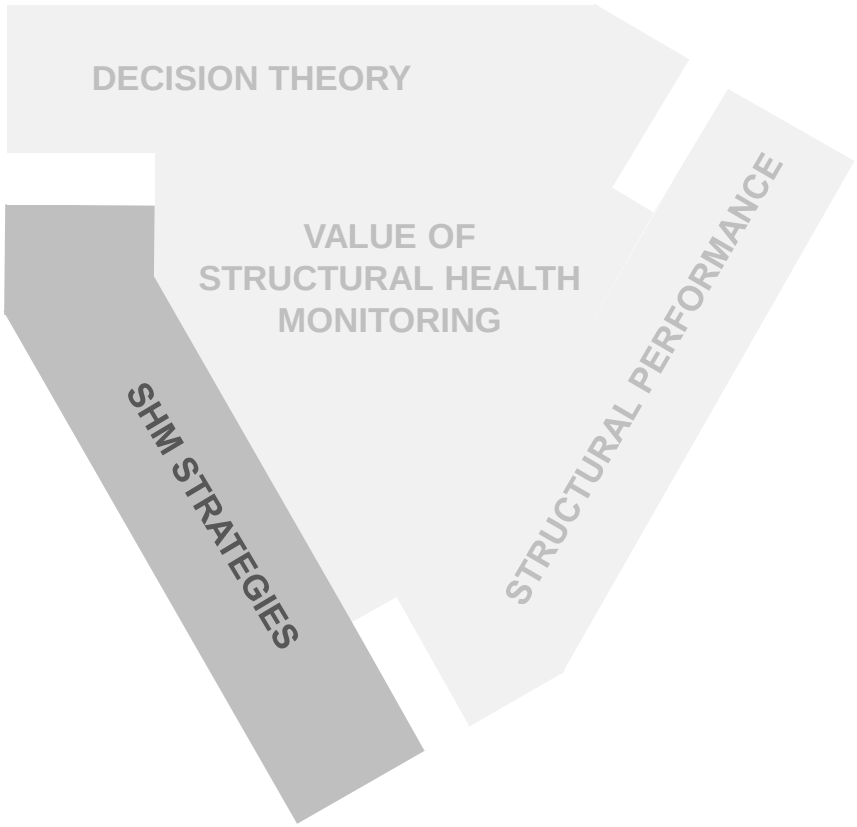
Summary

1. A newly developed SHM strategy for pressurised structural member damage detection (AirFMD) is introduced.

2. The AirFMD information is discussed in conjunction with the structural performance.

3. The value of the AirFMD information is discussed.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Historical developments of flooded member detection

FMD is meant to detect a leakage in a hollow steel member under water due e.g. a fatigue crack development in a redundant structural system.

- Originally diver or ROV operated based on acoustic impact, thermal profiling, radiographic methods, ultrasonic methods.
  - 100% probability of detection (POD) for at least 50% water filled members for ultrasonic-based FMD
  - 70% POD at 10% water fill

- In 2005 researchers from The University of Manchester proposed a fixed sensor and communication system for FMD

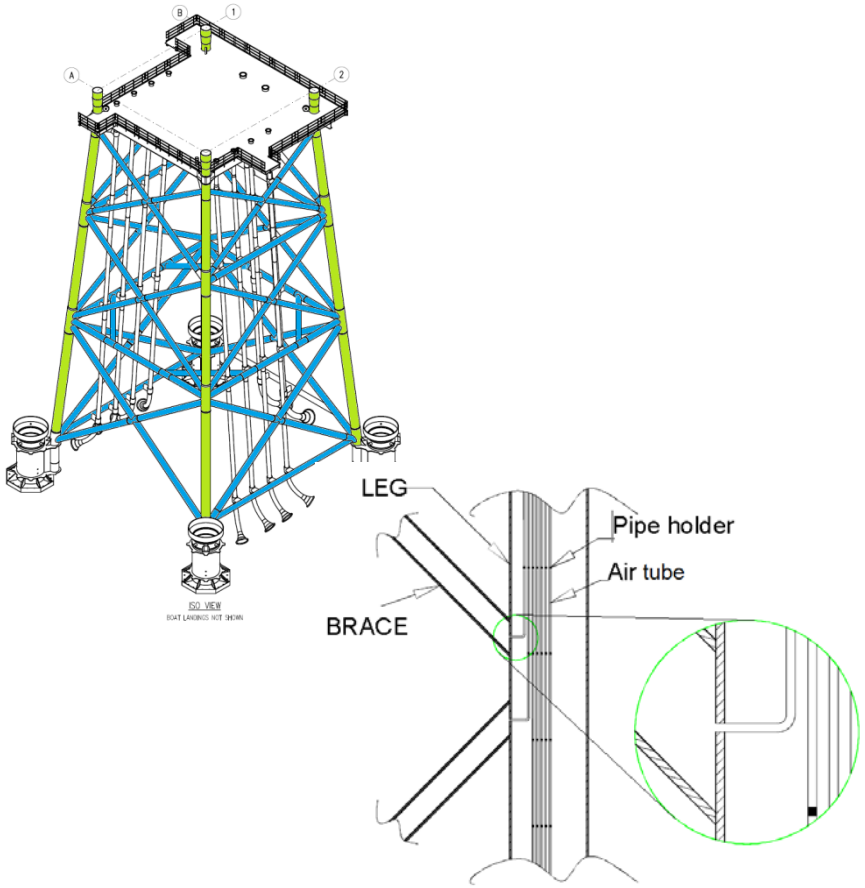
- All approaches are limited to the underwater part of the structure

Approach of pressurized structural member damage detection

A development team was formed to work on the challenge of SHM system development for offshore wind parks.

- SHM specialists (Neostrain, Krakow, Poland)
- Structural designer and consultants (JBO, Hamburg, Germany)
- SAFEINFRA research group, BAM Federal Institute for Materials Research and Testing, Berlin, Germany

Approach of pressurized structural member damage detection



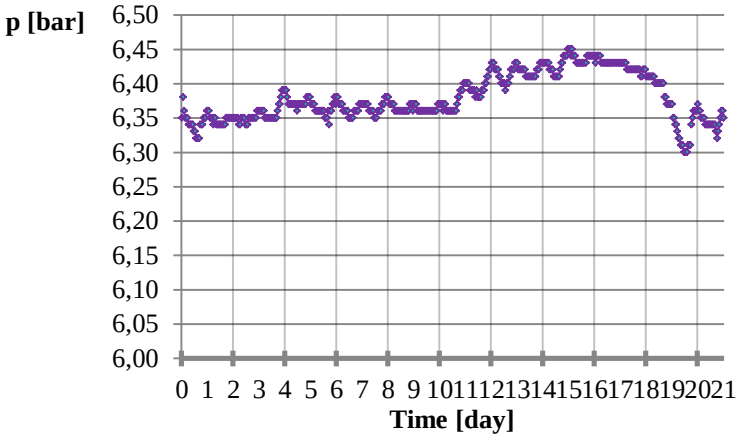
Structural hollow section members are air pressurized and the pressure is monitored.

- Higher than surrounding pressure.
- Pressure drop is an indication for a damage.

Connected and disconnected compartments can be designed which facilitate localisation.

AirFMD covers the structure under water, in the splash zone and above the water.

Approach of pressurized structural member damage detection

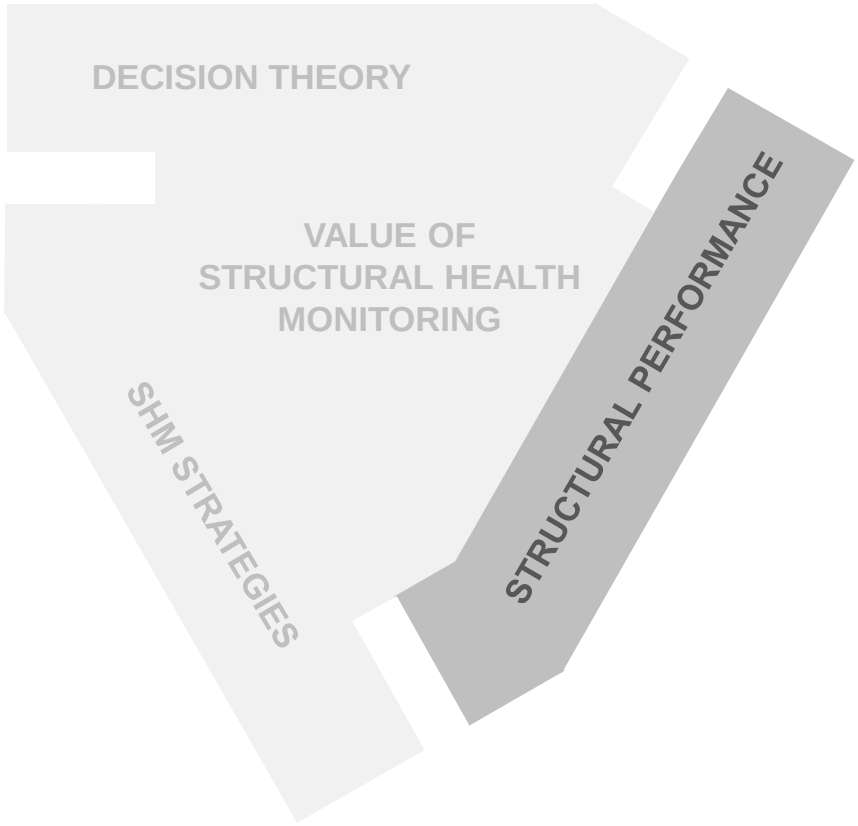


AirFMD is European patent pending and on the 4. Technology Readiness Level (TRL).

- Component and/or system validation in laboratory environment
- Basis: Technology Readiness Assessment Guide (2011), U.S. Department of Energy

Pressure stability was tested for temperatures between -20 ° and 40° C by Neostrain.

- Pressure loss negligible when temperature compensated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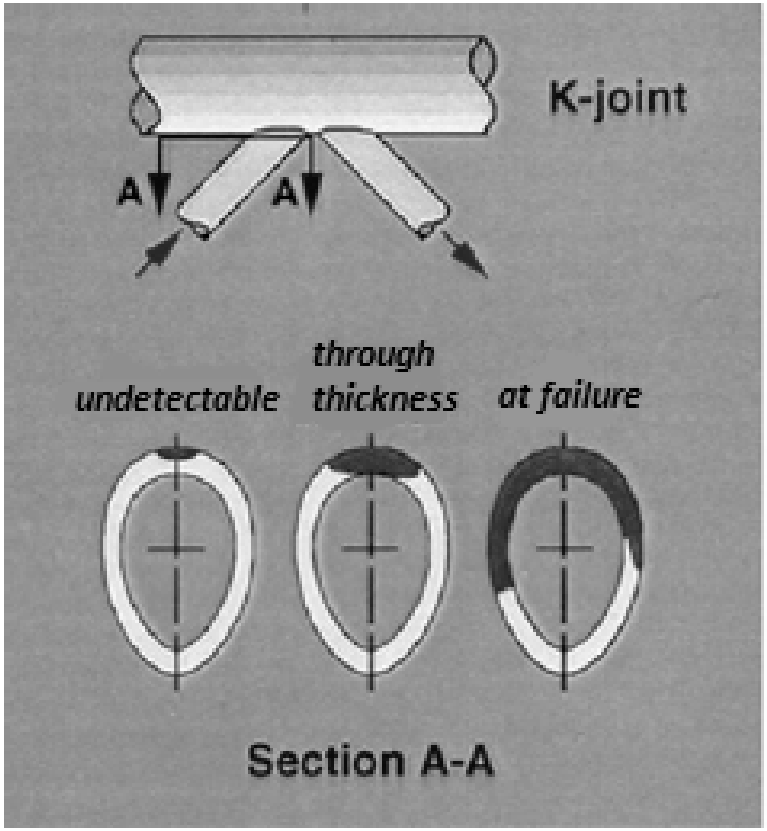
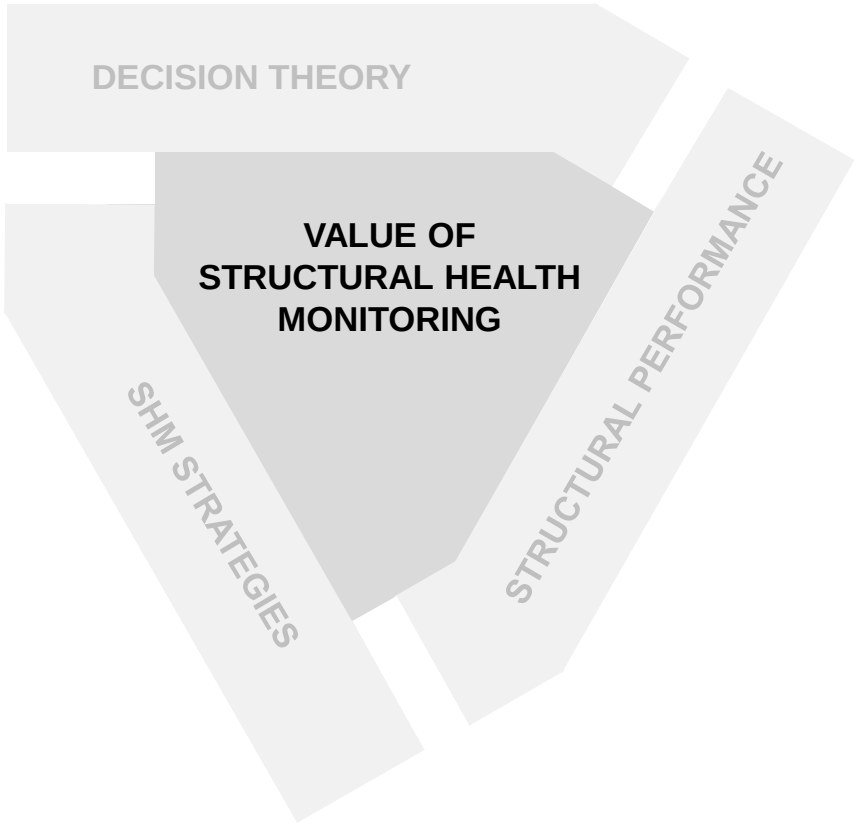
Structural integrity management utilizing AirFMD information



AirFMD indication triggers a localisation (when localisation with the system is possible) or repair.

- Indication based on leak before break must be fulfilled allowing for repair
  - Phase between through thickness and failure
- Large defects can be detected (in comparison to e.g. ACFM)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Value of AirFMD information

Discussion

- Coverage of a complete hollow section structure and (partly) replacement of inspections
  - Reduction of structural integrity management costs
- Robust AirFMD system design possible (sensors, data normalization and transfer)
- Detection of large componential defects
  - Component reliability maybe low
  - System reliability can still be high for redundant systems
- Cost of AirFMD information

Quantification of the Value of AirFMD necessary!

Conclusions

This is an example for networking.