

Condition monitoring of ships hulls using a Fibre Brag Grating system

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22. september 2023

Previous Research

- > Parallel research into ...
- Displacement monitoring of structures Gethin
 - Mainly long-span bridges, using GNSS
 - Up to 100Hz, 3D rapid displacements
 - Ability to extract frequency responses
- Deformation monitoring of infrastructure Werner
 - Structures including roads, tunnels and embankments
 - Using distributed fibre optic cables and Fiber Bragg Grating (FBG) approach
 - Long term deformations

Current Work

- > Bring together the ideas and approaches of the previous work
- > Short term displacements
- > High rate data capture and embedding of FBGs
- > Measure magnitude in both the time and frequency domains of displacements on a ship

Field Tests

- > FBG placed in the bow and engine room
- > GPS placed at 3 locations on the ship deck (2018 only)



FBG Sensing System

- > 16 strain sensors in the engine room
 - (3 in FBG strain rosette, 13 in FBG strain chain)
- > 1 temperature sensor in the engine room
- > 2 bare fibre FBG strain sensors in the bow
- High resolution (~ 1µm/m)
- Dynamic measurement (1kHz)
- Surface mountable sensors



FBG – Sensor Mounting

> Engine room

- 1 strain rosette with 3 FBGs
- 1 strain chain with 13 FBGs
- Directly glued on outer hull



principle 9µm core fiber Ø3mm pigtail Optimet PKF Polyamide Splice Protection 6µm core fiber FBG **FBG** FBG Ø0.7mm peek coating 2 " n ----13x Strain FBG spaced at 60cm (2x or 4x Strain FBG spaced at 60cm) 1x or 2x PKF-OTC compensation element @ customer selected strain FBG location Resource: https://www.hbm.com/

Strain chain

FBG Arrangement; Strain Chain

Mounting scheme



Installed chain with protection



FBG data processing



- Spectrum up to 100Hz
 - Fundamental
 frequencies below
 20Hz
 - Harmonic frequencies
 up to 100Hz



FBG data processing











2023

- New field tests conducted
- Our FBG system attached to existing fibres on Smyril
- > Fibres worked after 6-years
- Initial results look promising



Conclusion

- > We have introduced the application of FBG to measure the dynamic deformations of a ship
- Including the ship's dynamic response in open ocean
- > Vibrations caused by the engine and wave action on the ship
- Identify consistencies over long term
- > Identify changes in characteristics, identifying damage or deterioration
- > Help future designs
- > Current project is also focusing on the effect of damaged propeller on data
- > Equipment and expertise now in the Faroe Islands

Acknowledgements

- > Strandfaraskip Landsins and staff, in particular First Mate Óli Hansen
- The initial project was partly funded by the Ningbo Science and Technology Bureau as part of the International Academy for the Marine Economy and Technology (IAMET) Project 'Structural Health Monitoring of Infrastructure in the Logistics Cycle' (grant number 2014A35008)
- The current work is funded by Granskingarráðið HeAlth and EnviRonmental MONItoring of Ships and PropEllers (HARMONISE)

