Innovative Cable Design for Distributed Sensing Applications based on Stimulated Brillouin Scattering

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An innovative optical fibre cable designed for Brillouin sensing applications is presented. The stages of the project are discussed, and the cable performance are tested through numerical modelling and experiments.
Keywords: Optical Fibre Cable, Stimulated Brillouin Scattering

1. Introduction

In distributed sensing applications, the techniques based on the Stimulated Brillouin Scattering (SBS) gained high interest across the scientific community for their ability to reach spatial resolutions of the order of few centimetres [1-2]. In real applications, the measurement accuracy does not depend only on the interrogator. As such, the mechanical coupling between the cable and the host structure is a fundamental point to consider during the design phase. In this study, the authors introduce a novel sensing cable optimized for distributed application based on the SBS.

2. Sensing Cable Design

During development process two cable prototypes were produced. In the first design stage the objective was to produce a sensing cable with the following properties: (i) optimized mechanical coupling with the structure; (ii) protection against harsh environmental conditions; (iii) stable attenuation and sensitivity over the range of operational conditions; (iv) capability of withstanding large deformations; (v) absence of creep and other long-term phenomena capable to degrade the measuring performance of the cable. Fig.1 Shows the concept design of the first cable prototype.

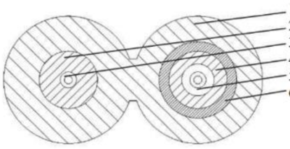

Fig. 1 Schematic of the first cable prototype

In the second phase, it was decided to make some changes in the manufacturing process: (i) it was decided to lower the speed ramp-up to ensure a better a uniformity of the fibre pre-stress; (ii) the drag on the temperature compensation fibre was reduced adding a silane-based lubricant; (iii) the cable jacket material was changed to avoid the risk of slippage with the inner fibre tubing; (iv) the outer surface of the cable was machined with a different knurling tool to realize a structured surface and improve the mechanical coupling with the host structure. Theses considerations returned the design illustrated in Fig. 2.

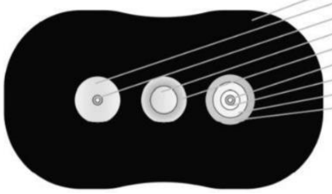

Fig. 2 Schematic of the second cable prototype

3. Testing and Conclusions

The two cables performance were tested performing a tensile test on an aluminium specimen, bonding them over a length of 270 mm at different load levels, posing the attention on their strain transfer capabilities. Fig 3 shows the results comparing together numerical, analytical and experimental data.

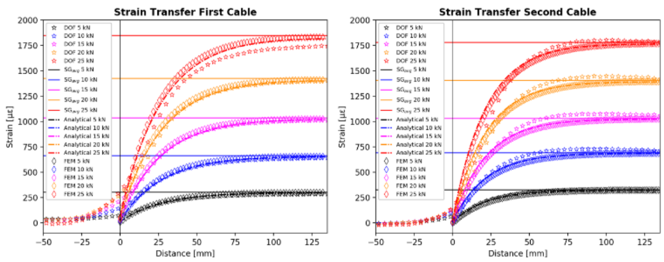

Fig. 3 Analytical, numerical and experimental data of the first cable

The testing phase showed that the second cable could transmit the strain from the specimen to the fibre core at a higher rate.

References

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