Design and Simulation of a Gel-Sealing Joint Element

Student

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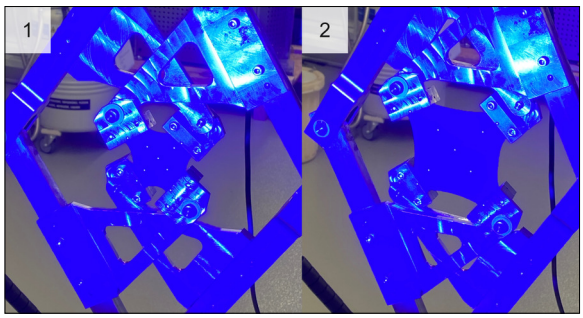
Initial Situation: The development and optimization of a gel-sealing element used in fiber optic network splice closures require transitioning from one elastomer-sealing material type to another. This shift presents challenges in maintaining the sealing performance, especially due to changes in material properties. The project first focused on ensuring the integrity and reliability of the gel-sealing element, which plays a crucial role in protecting sensitive fiber optic connections from environmental factors such as moisture, dust, and mechanical stresses. A new adhesive had to be identified and evaluated, considering the requirements for effective bonding between the gel material and the surrounding components. Additionally, a Finite Element Analysis (FEA) was employed to simulate and optimize the performance of the sealing element under a compression loading state.

Approach: A thorough investigation was conducted to identify adhesives that meet performance criteria while considering factors like bonding strength, application feasibility, and cost efficiency. Various pretreatment methods, such as surface cleaning, plasma treatment, and primers, were applied to enhance the bonding process. Extensive material characterization was performed to calibrate the hyperelastic material constitutive parameters of the gel, which was essential for developing a precise prediction of the material behaviour. This material model was integrated into the FEA simulations considering parameters such as pressure distribution, material deformation, and interface interactions. However, the simulation process encountered convergence issues, limiting the ability to fully replicate real-world performance. Despite this, the study provided valuable insights into the material properties and simulation techniques, paving the way for future refinements.

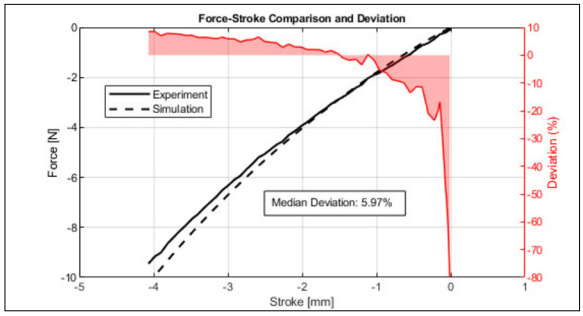
Result: Several adhesives were identified that demonstrated good bonding performance, with strong adhesion between the gel and structural components under various conditions. The most promising adhesives performed well in tensile-shear and peel tests, and key surface pretreatments improved bond strength. The material characterization provided a solid foundation for future simulations. Although the intended design optimization could not be fully realized, the study contributed valuable knowledge regarding both adhesive selection and the challenges of modeling complex hyperelastic materials. The research provides a strong starting point for further development, guiding future iterations toward more reliable and efficient sealing solutions in fiber optic applications.

New Adhesive: No Failure at 540° Twist
Own presentment

Mechanical Characterization, Equibiaxial Testing. 1: Starting-Position, 2: End-Position
Own presentment



Validation of Reaction-Force with an Arruda-Boyce Material Model
Own presentment



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