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# Shape Sensing and Damage Detection of Thin-Walled Cylinders Using an Inverse Finite Element Method

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**Abstract :** Thin-walled cylinders are often used by the offshore industry as columns of floating installations. Based on observed strains, the inverse Finite Element Method (iFEM) may rebuild the deformation of structures. Structural Health Monitoring uses this approach extensively. However, the number of in-situ strain gauges is what determines how accurate it is, and for shell structures with complicated deformation, this number can easily become too high for practical use. Any thin-walled beam member's complicated deformation can be modeled by the Generalized Beam Theory (GBT) as a linear combination of pre-specified cross-section deformation modes. GBT uses bar finite elements as opposed to shell finite elements. This paper proposes an iFEM/GBT formulation for the shape sensing of thin-walled cylinders based on these benefits. This method significantly reduces the number of strain gauges compared to using the traditional inverse-shell finite elements. Using numerical simulations, dent damage detection is achieved by comparing the strain distributions of the undamaged and damaged members. The effect of noise on strain measurements is also investigated.

**Keywords :** damage detection, generalized beam theory, inverse finite element method, shape sensing
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