Effect of Local Buckling in Autofrettage Process on the Fatigue Behavior of the Liner in Al/CFRP Composite Pressure Vessels

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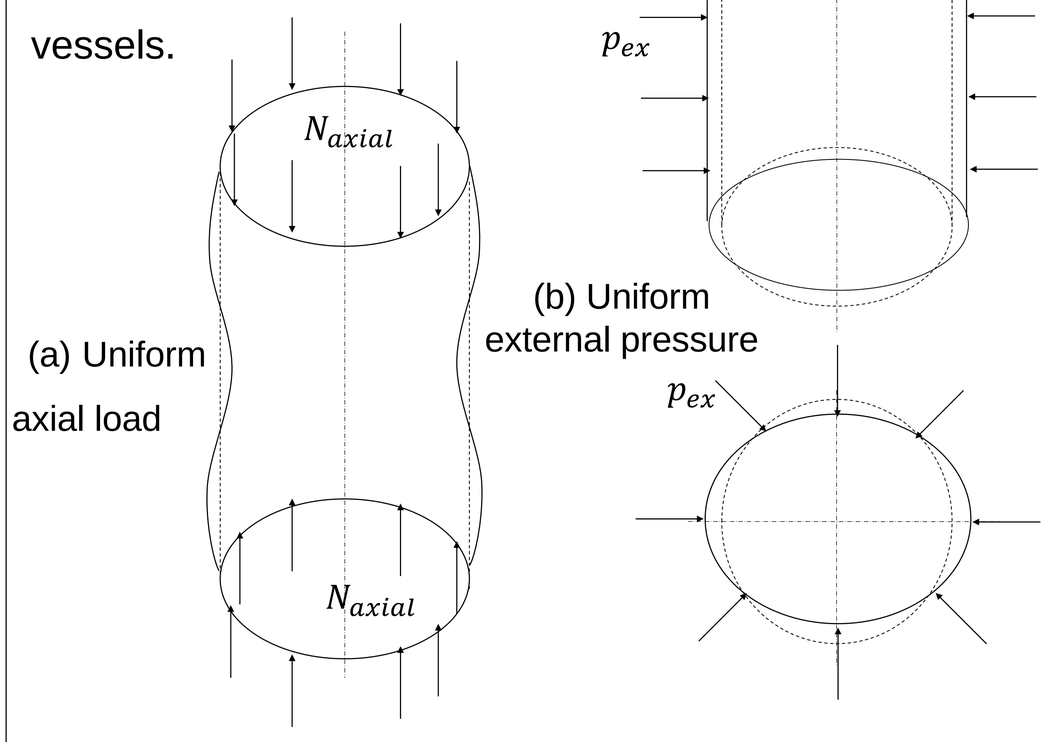
1. Introduction

Liner buckling: One of the failure mechanisms in Al/CFRP (Carbon Fiber Reinforced Plastic) composite pressure vessels.



(a) Uniform axial load

(b) Uniform external pressure

Fig. 1 Buckling load conditions

Reasons:

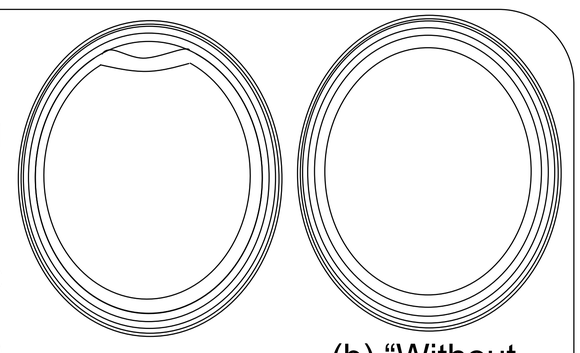
- Axial load
- External pressure
- Combined loads

Effects:

- Instability
- Decreasing load-carrying capacity
- Reducing fatigue life

2. Objective

To determine the effect of buckling during autofrettage process on the deformation, stress components, and equivalent plastic strain of the liner when the vessel subjected to the cyclic pressure

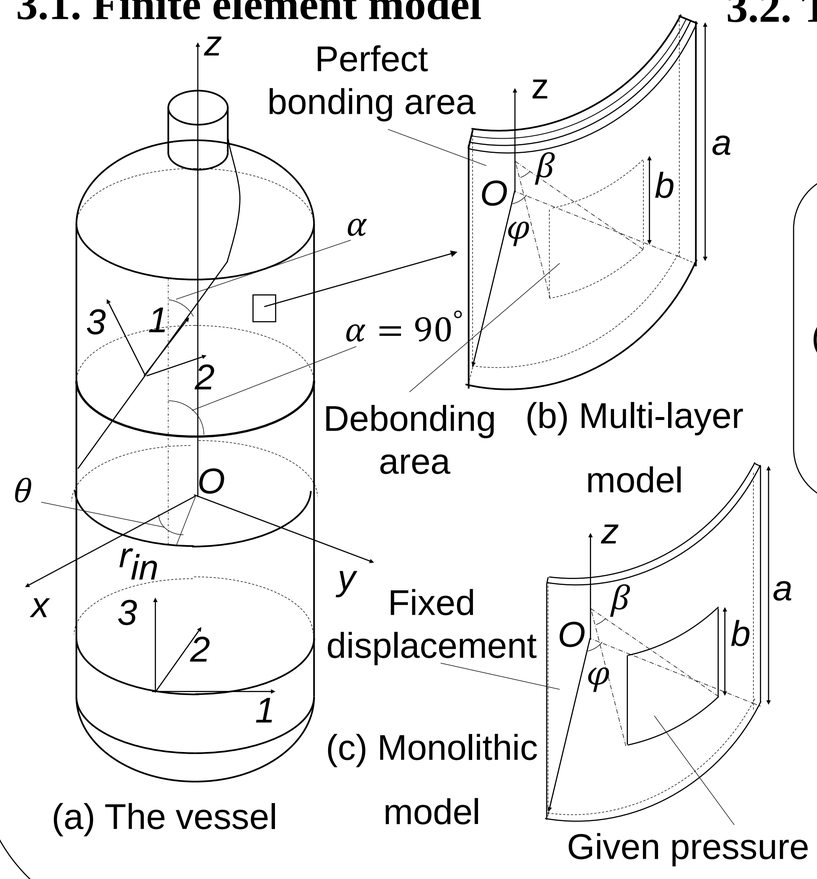


(a) "With buckling" (b) "Without buckling"

Fig. 2 Cases with and without consideration of buckling

3. Methodology

3.1. Finite element model



(a) The vessel (b) Multi-layer model (c) Monolithic model

Fig. 3 Schematic diagram of analyzed models

3.2. The analytical procedures

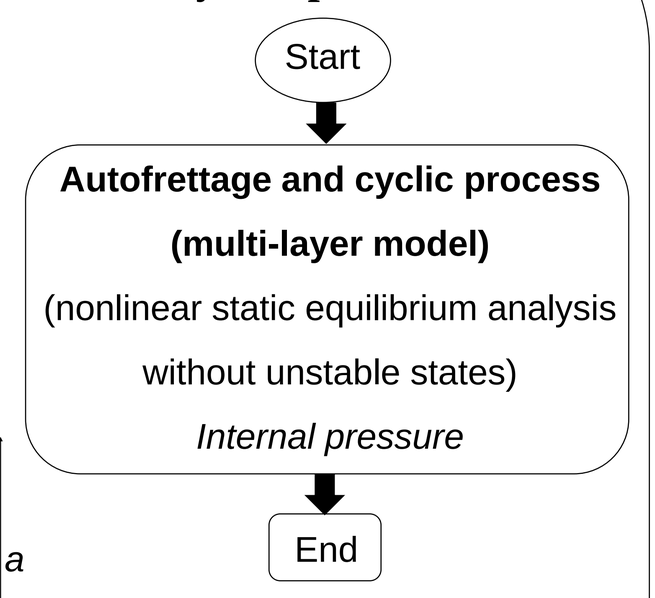


Fig. 4 The flow chart of the finite element analysis in case without buckling

3.2. The analytical procedures (cont…)

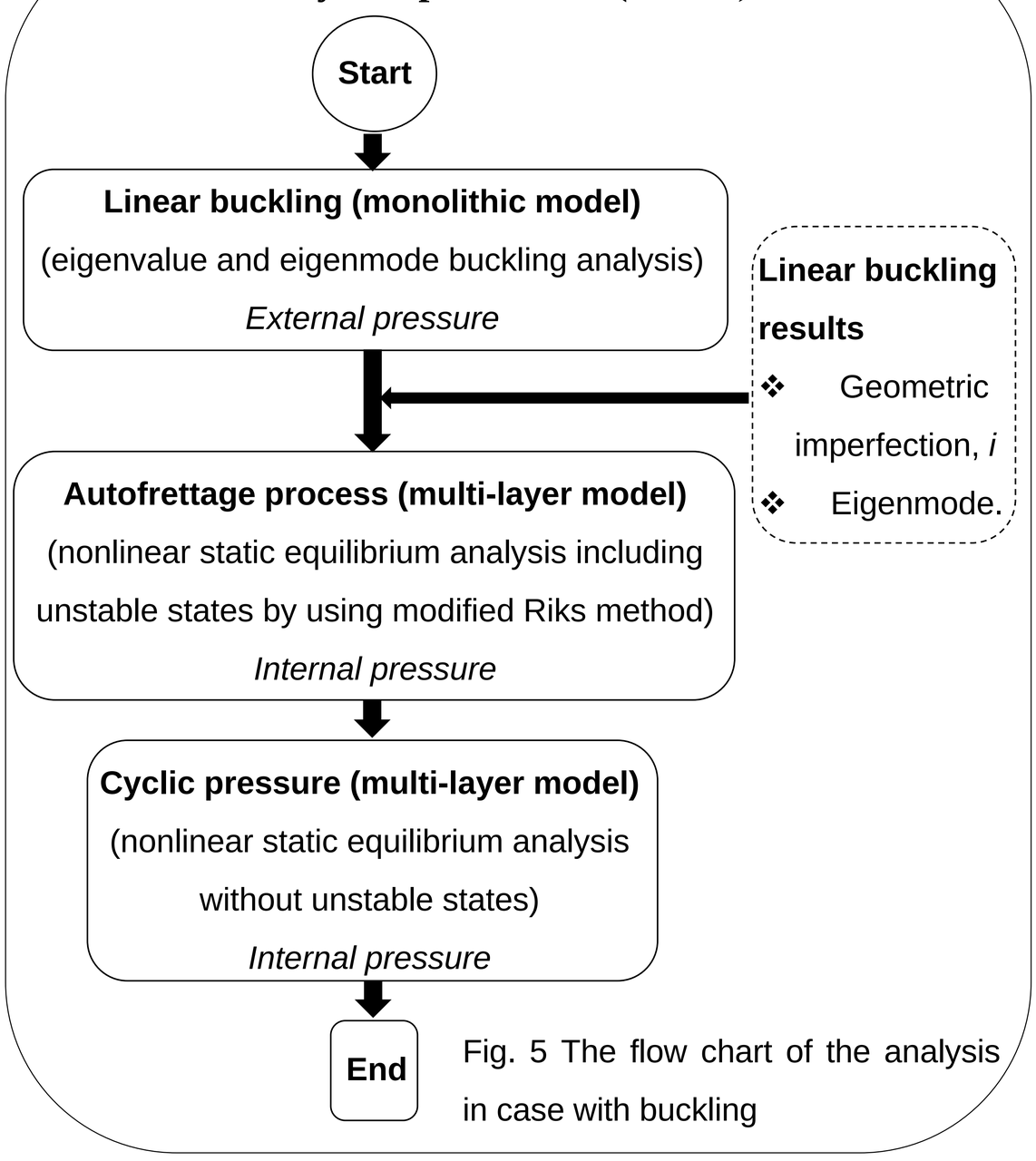


Fig. 5 The flow chart of the analysis in case with buckling

4. Results

Equivalent plastic strain:

- Inhomogeneous and greater with buckling
- Changes slightly during the cyclic process with buckling
- Constant values without buckling

Displacements and stresses:

- Fluctuate considerably with buckling
- Almost unchanged values without buckling
- Higher values at the de-bonding region during the cyclic pressure

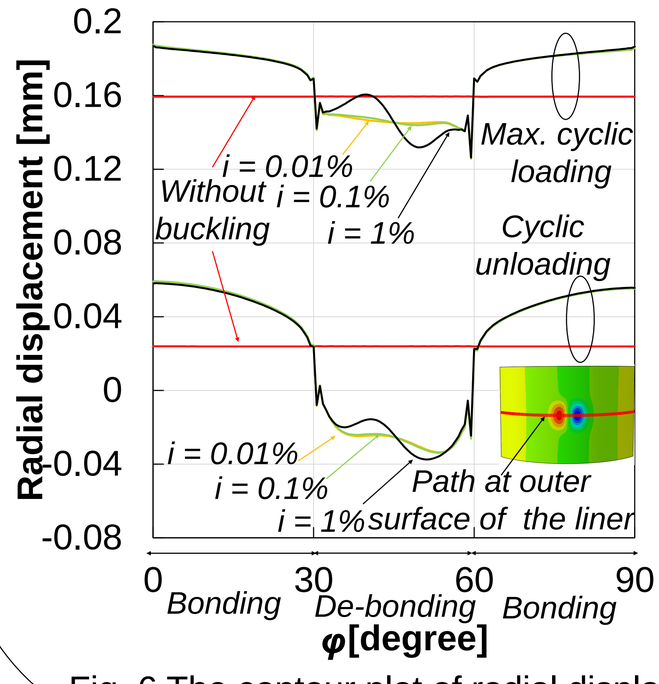


Fig. 6 The contour plot of radial displacement

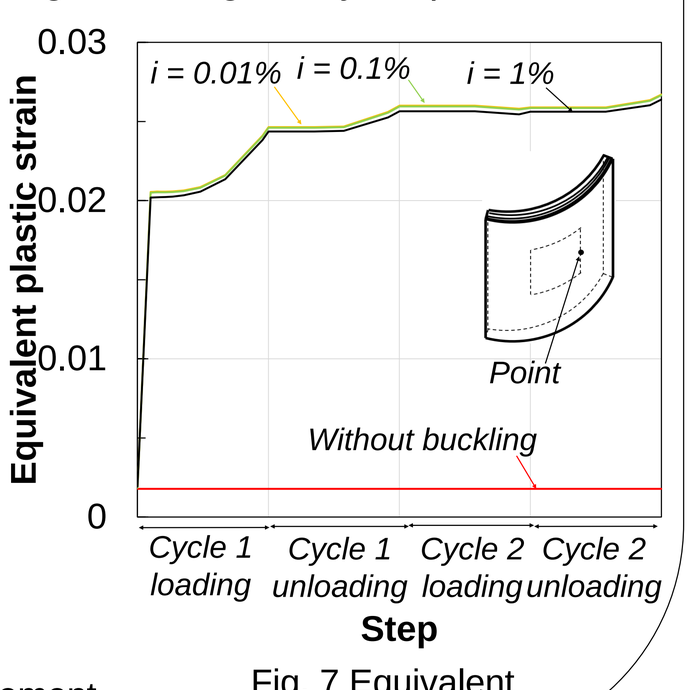


Fig. 7 Equivalent plastic strain