Influence of Fiction on the Nonlinear Buckling Problem of Shallow Spherical Shells Contacting with Rigid Walls

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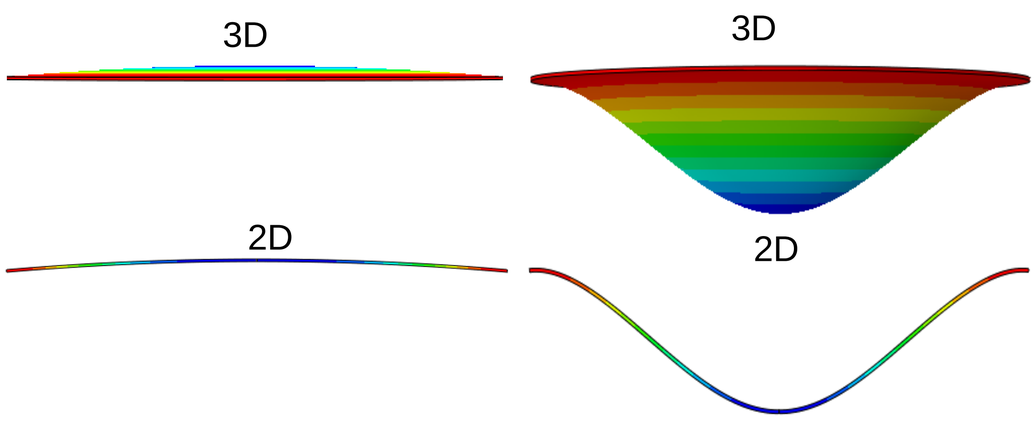
1. Introduction

Buckling: A severe failure of the shallow spherical shells



(a) Unbuckled state (b) Buckled state

Fig. 1 States of buckling problem

Reasons: Uniform external pressure

Effects:

- ❖Loss of stability and stiffness
- ❖Decreasing load-bearing capacity
- ❖Failure of the structure

2. Objective

To examine the effect of friction between the shallow spherical shells and rigid walls on the buckling behaviors under uniform external pressure and comparing the results with the hinged end and clamped end cases.

3. Methodology

3.1. Finite element model

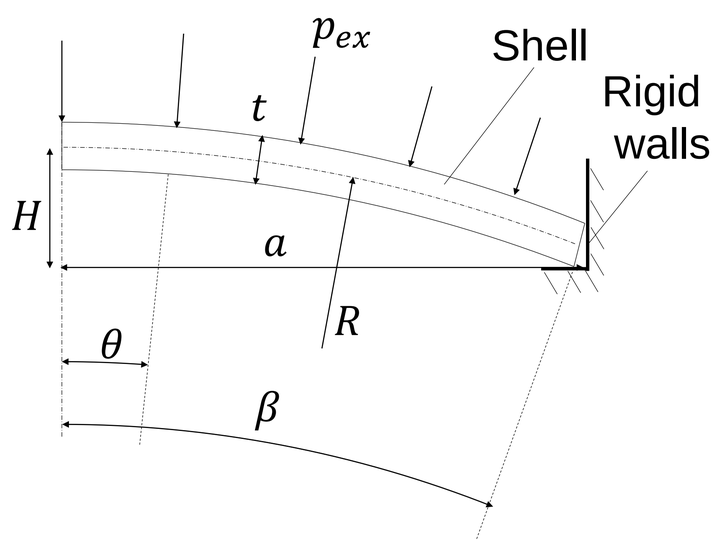


Fig. 2 Axisymmetric model

3.2. The analytical procedures

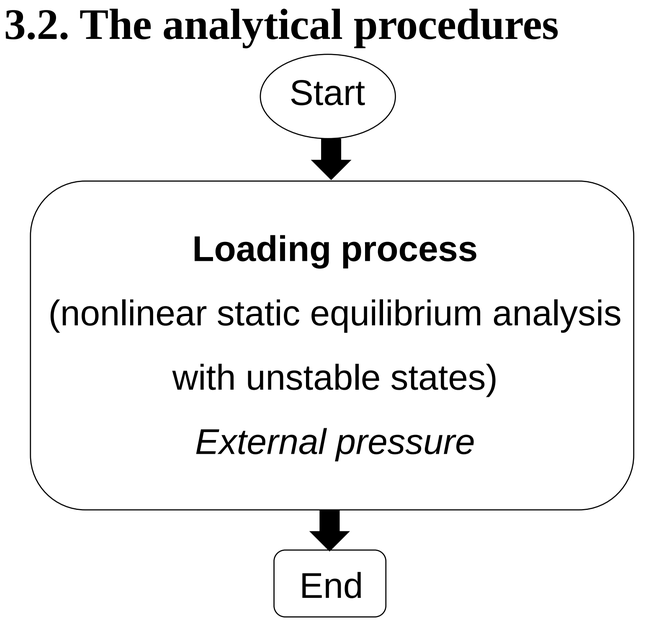


Fig. 3 The flow chart of the finite element analysis

4. Results

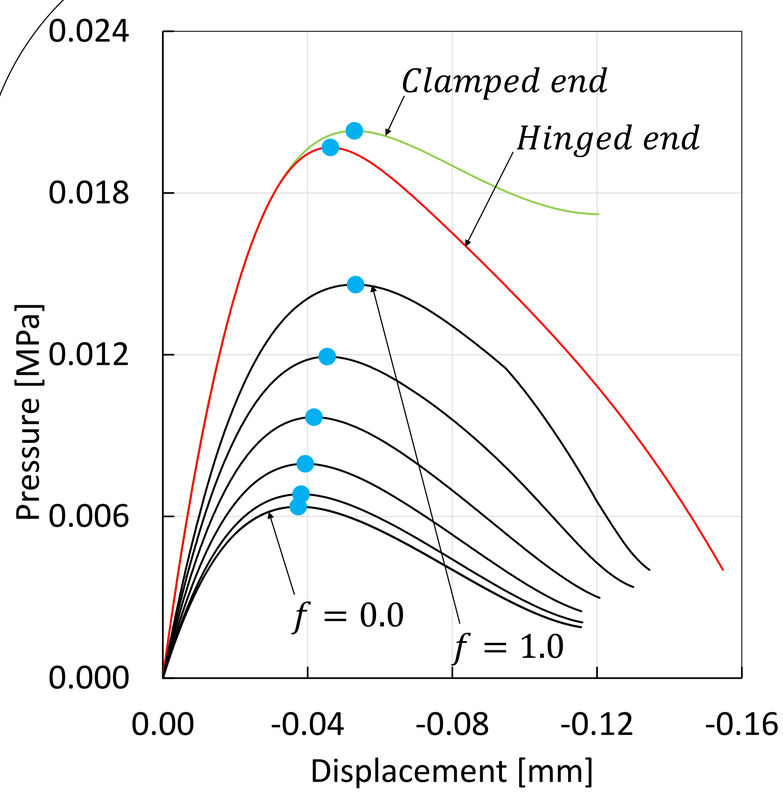


Fig. 3 Pressure – displacement curves

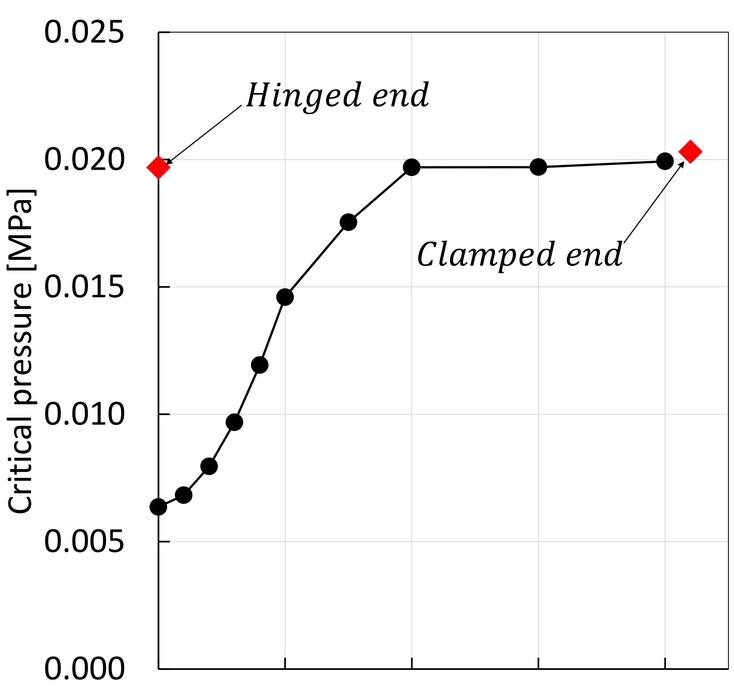


Fig. 4 The critical pressure – friction coefficient relationship

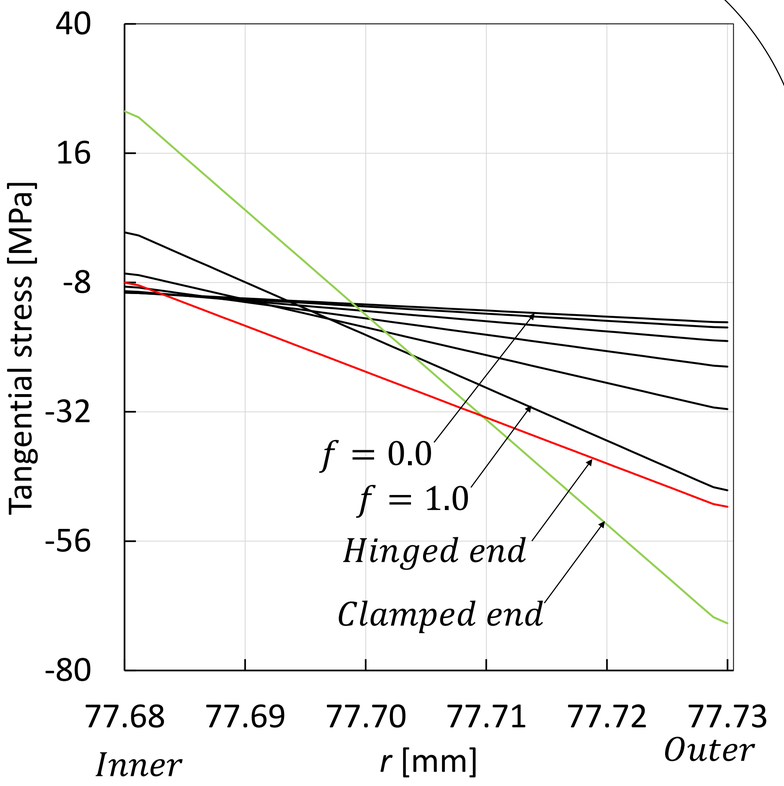


Fig. 5 Tangential stress through the thickness

In Fig. 3

- **The blue circular points:** the critical points
- **The stage before the blue circular points:** pre – buckling stage and stable states
- **The stage after the blue circular points:** post – buckling stage and unstable states

5. Conclusions

- **Friction shows a strong effect on the buckling behaviours of shallow spherical shells under uniform external pressure.**
- **Both critical pressure and critical displacement increase nonlinearly with the increasing of friction coefficient and finally these values converge to the values of clamped end case.**
- **In case of frictionless, the shell exhibits easier rotation than the hinged end case.**
- **Tangential stress throughout the thickness or bending moment of the shells presents a significant difference with distinct coefficients of friction**