

An analytical investigation of the collapse of asymmetrically corroded pipes under external pressure

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Coexistence of internal and external corrosion

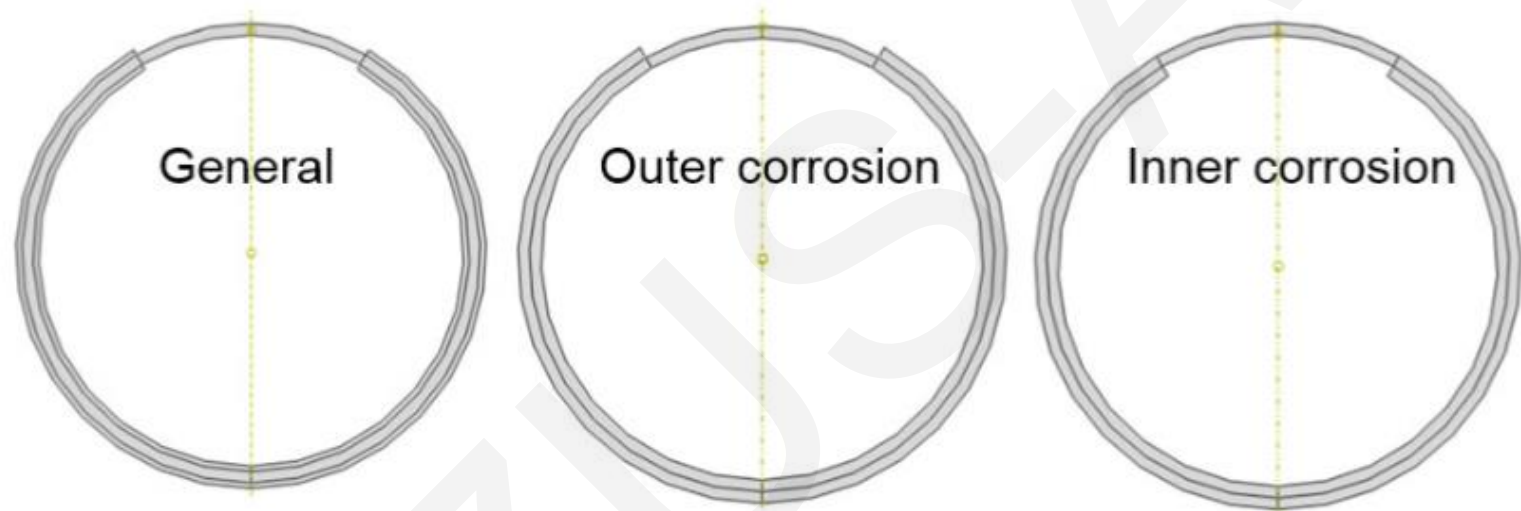
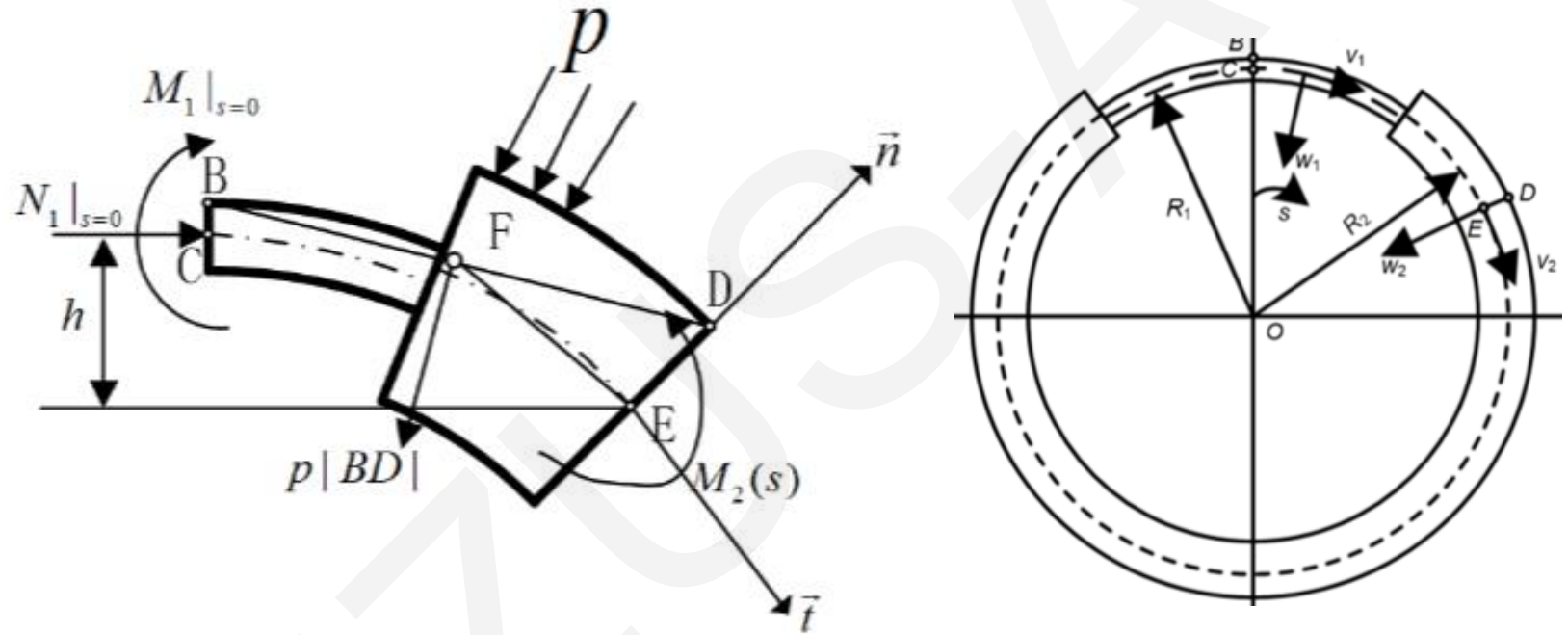


Fig. 2 Three types of geometric models

Internal and external corrosion coexist. The corrosion misalignment parameter can not be ignored!

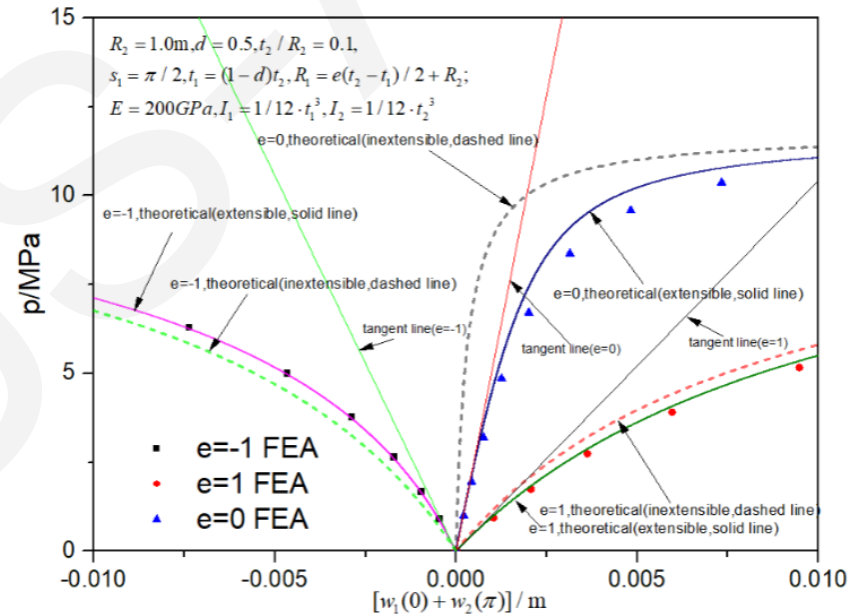
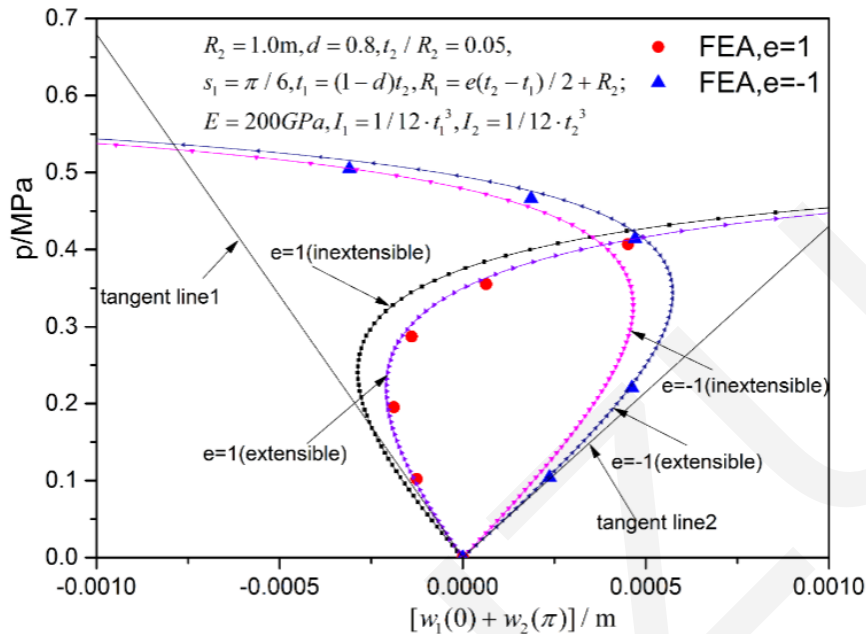
Governing differential equation derived



$$EI_i/R_i^2(w_i'' + w_i) + pR_iw_i = C + EI_i/R_i^2 \cdot pR_i(R_i + t_i/2)/Et_i - 1/8 \cdot p(t_i^2 - 4R_i^2).$$

Terms related to corrosion asymmetry

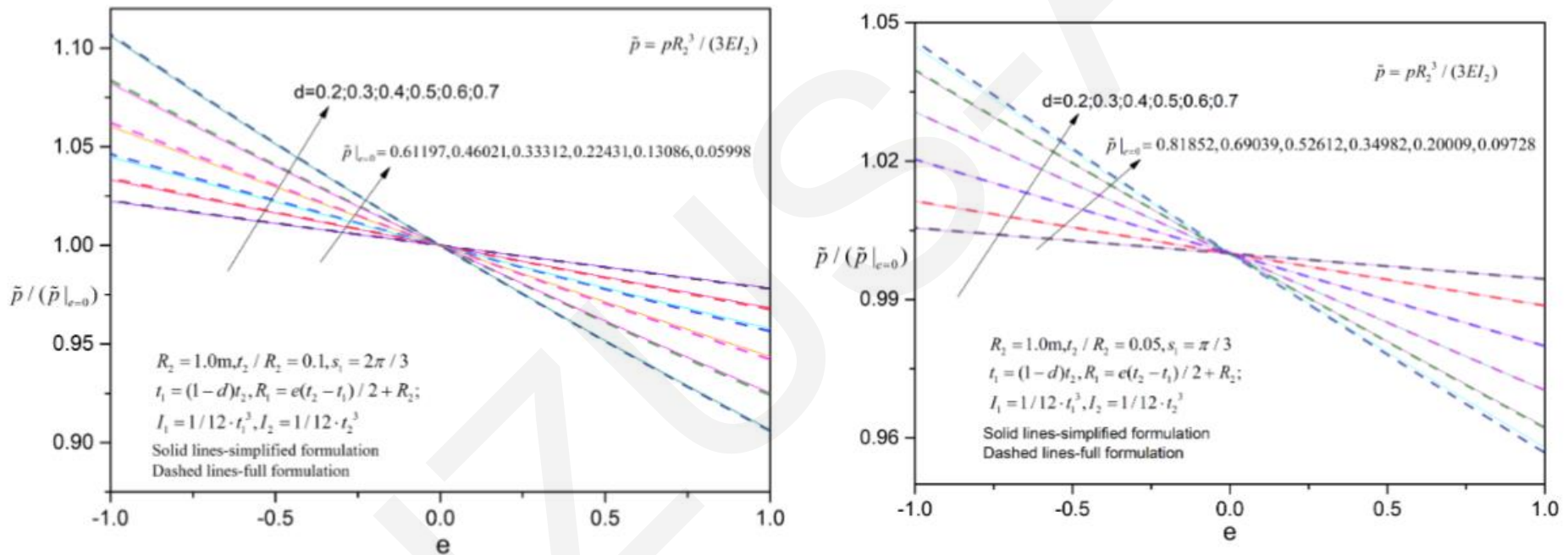
Effect of membrane compression



Membrane deformation affects the initial phase significantly and **must be** included!

Full and simplified continuity conditions compared

The results under two continuity conditions remain very close.



Effect of two continuity conditions(Full and simplified) is compared for bifurcation pressures.

Conclusions

- (1). The derived inhomogeneous formulation's load-displacement curve agrees well with the FEA results.
- (2). The effect of misalignment parameter significantly affects the deformation paths even when the ring is thin (e.g., $t^2/R^2 = 0.05$).
- (3). The rigorous adoption of Euler-Bernoulli beam assumption leads to a complex continuity condition equation, however a comparison analysis shows that the simplified continuity condition by simply requiring no abrupt jump of tangential displacements yields almost the identical results up to very small error.
- (4). The initial deformation is highly affected by membrane extensibility, and the perturbative solution in this paper (Appendix D) is unexpectedly non-trivial and agrees well with the FEA predictions.
- (5). Initial slope calculation shows that $\theta = 0$ is not necessarily the initially stiffest case.