Confinement effects on the buckling and post-buckling of cylindrical shells subjected to external pressure: Experiments and simulations

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Résumé

The mechanical behaviour and stability of confined shells subjected to external pressure loading have been the subject of many studies, mainly for buried deep pipelines applications. Previous research has always focused on the uniform external groundwater pressure. Meanwhile, there is a lack of knowledge regarding the buckling and post-buckling regime induced by the "convergence" of the medium ensuring the confinement. In this study, the mechanical behaviour of thick and thin shells submitted to an external pressure induced by the "convergence" of the external confinement medium is explored experimentally and numerically. A specific test setup is built and a large experimental parametric study is conducted, where several confinements rigidities are considered. The nature of the external confinement(expanded polystyrene, sand, clay, or ice), the type of confinement, discrete or local instead of the total (whole surface of the shell), are studied. The results showed that the buckling load and the buckling mode strongly depend on the compression rigidity and on the configuration of the confinement. A considerable increase in the buckling capacity for total stiff confinement is observed, the strengthening provided by local confinement or weak total confinement being slightly less. In addition, relevant FE simulations are conducted where two-dimensional and three-dimensional nonlinear finite element models are gauged, and a good correlation is obtained.

Mots-Clés: Buried pipe, Buckling with contact, Post, buckling behavior, External pressure, "Convergence" of confinement, Finite element method, Experiments

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