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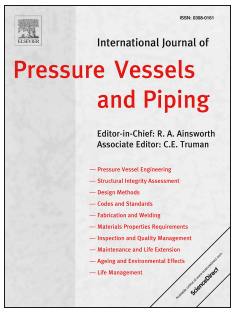

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Influence of ovalisation on the plastic collapse of thick cylindrical tubes under uniform bending

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Abstract

An accurate assessment of the bending resistance of thick cylindrical metal tubes is necessary for the safe and efficient design of pipelines, piles, pressure vessels, circular hollow sections and other common tubular structures. Bending tests continue to be widely performed as part of many engineering research programmes, but despite their ubiquity they often generate results that are difficult to interpret. Discrepancies from the attainment of the classical full plastic moment are common and often attributed to a mixture of ovalisation, local buckling, imperfections and strain hardening. However, the effects of these phenomena are yet to be quantified in isolation, even for a system as classical as a cylinder under uniform bending.

The goal of this computational study is to quantify the extent to which geometrically nonlinear effects, specifically ovalisation and bifurcation buckling, may depress the resistance of a thick perfect cylinder under uniform bending that would otherwise be expected to attain the full plastic moment. Simulations are performed using two- and three-dimensional finite element models with a simple ideal elastic-plastic material law that excludes the influence of strain hardening. Additionally, the study aims to arm designers of test programmes on the bending of tubulars with 'rules of thumb' to approximately quantify the likely influence of tube length on their results, recently shown to be an important parameter controlling geometric nonlinearity. For thick tubes, ovalisation at the plastic limit state under bending is found to be almost negligible.

Keywords

Thick tube; cylindrical shell; plastic collapse; ovalisation; plane strain; length effect.

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