Wang, Y.-Y., Liu, M., Song, Y., Stephens, M., Peterson, R., Gordon, J., and Horsley, D., Strain-Based Design of Pipelines, Proceedings of 18th Joint Technical Meeting of EPRG/PRCI/APIA, 2011, San Francisco, CA, USA, Paper no. 15

Abstract

Strain-based design (SBD) is a rapidly developing technology that can be applied to the construction of new pipelines and the maintenance of existing pipelines. SBD is often necessary for pipelines expected to experience large longitudinal strains typically associated with ground movements. This paper covers the development of tensile strain-based design models under a US DOT and PRCI co-funded project. Extensive small-scale material characterization tests and full-scale pressurized pipe tests were conducted in support of the model development process. A four-level approach is proposed for the tensile strain design models. The Level 1 procedure provides the estimated tensile strain capacity (TSC) in a tabular format for quick initial assessment. The Levels 2 and 3 procedures use a set of parametric equations that allow the computation of tensile strain capacity with the input of pipe's dimensional and material property parameters. The Level 4 procedure permits case-by-case finite element analysis that should only be used by seasoned experts in special circumstances where lower level procedures are judged inappropriate. The tensile strain design models may be used for (1) the determination of tensile strain capacity for a given set of material properties and flaw size, (2) the determination of flaw acceptance criteria for a given set of material properties and target tensile strain levels, (3) the selection of material properties to achieve a target strain capacity for a given set of flaw size, and (4) the optimization of the tensile strain capacity by balancing the requirements of material parameters, such as weld strength (thus weld strength mismatch level) versus toughness. The basis of the model development, model structure, and organization of the input parameters for the model applications are covered in the paper.

Keywords

Strain-based design, Tensile strain capacity, High strength pipelines, Fracture mechanics