ABSTRACT

The second symposium on strain-based design for pipelines was convened during the 2008 ISOPE conference in Vancouver, Canada. The second symposium built upon the progress made at the first symposium with increased industry participation indicating the importance of this technical challenge. Experts in materials, analysis, and construction convened to discuss the latest progress towards strain-based design pipeline capacity and demand research. The key themes of the second symposium included pipeline construction, design, engineering mechanics, assessment methodologies, materials, and experimentation. The design and assessment of pipelines subject to large strains continues to have many unsolved technical challenges. This paper will detail highlights from the 2008 conference and will serve as a starting point for the Third (2009) ISOPE Strain-Based Design Symposium.

KEY WORDS: Strain-based-design; tensile capacity; fracture assessment; buckling; pipeline

INTRODUCTION

Within the last decade the oil and gas industry has started to focus its efforts on developing pipeline concepts that are capable of large longitudinal deformations (i.e. longitudinal strains greater than 0.5%). The need for pipelines capable of withstanding large deformations is due to the fact that some current and future pipelines will need to plastically stretch, bend and compress to accommodate local or global movement of the surrounding environment. The surrounding environment is most often soil, rock, permafrost, solid ice, or some combination of these. Soil and rock can force the pipeline to displace through sudden extreme events such as earthquakes or gradually over time due to soil settlement. Changes in solid ice or permafrost volume through temperature fluctuation can also lead to large pipeline displacements. Figure 1 illustrates how ice and permafrost can induce large deformations in a pipeline. In other cases floating ice can also impact a subsea pipeline and cause it to deform plastically (Kan, Weir, Zhang, Lillig, Barbas, Macia, and Biery, 2008).

Figure 1–Frost Heave and Thaw Settlement for pipeline buried in permafrost (Kan, Weir, Zhang, Lillig, Barbas, Macia, and Biery, 2008)

Terms such as strain-based design (SBD) or strain capacity are used to describe pipelines where the traditional stress-based design has been augmented with additional requirements that are thought to assure target levels of longitudinal strain capacity in the pipeline. Currently these terms lack rigorous definition in most codes and standards. To date many industry personnel consider a pipe design to be a strain-based design if the axial strain capacity is required to exceed 0.5%. The value of 0.5% is chosen because that is where the standard “stress based” flaw assessment codes cease to give explicit guidance. Others would consider that a strain-based design would also apply to any pipe design where the pipe is expected to be stressed to the yield strength of the parent pipe material.

The main challenges associated with developing a strain-based design have been summarized by Barbas and Weir (2007). Some of the challenges are consistent with traditional stress based design, while other challenges are specific to strain-