The Third (2009) ISOPE Strain-Based Design Symposium - A Review

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ABSTRACT

The third symposium on strain-based design for pipelines was convened during the 2009 ISOPE conference in Osaka, Japan. The symposium addressed the materials and design challenges associated with strain-based design through seven focused sessions in modeling, materials developments, as well as tensile and compressive strain capacity. Experts from around the world in materials, pipeline design, analysis, and construction convened to discuss the latest progress towards strain-based design pipeline capacity and demand research. This paper will detail highlights and key learnings from the 2009 conference and will serve as a baseline for the Fourth (2010) ISOPE Strain-Based Design Symposium.

KEY WORDS: Strain-based-design; tensile capacity; compressive capacity; girth welding; buckling; pipeline

INTRODUCTION

Historically the oil and gas industry has designed transmission pipelines with the internal pressure of the fluid to be transmitted as the limiting stress state. In recent times an increasing fraction of major transmission lines have been subjected to significant loads from the environment which they are traversing. As these loads increase above the yield strength of the materials used to construct the pipeline, pipeline designers must consider alternate design criteria to ensure a safe design. Sources of these increased environmental loads are illustrated in Figure 1. In arctic regions of the world, areas of discontinuous permafrost can lead to thaw settlement or frost heave (pictured) depending on the relative temperature of the pipeline to the surrounding soil. Seismic loading from fault crossings or areas of soil instability can also lead to large imparted forces on pipelines. Since 2007 ISOPE has recognized this emerging topic of offshore and arctic pipeline design and construction through dedicated strain-based design symposia, bringing together recognized experts in pipeline design, materials, and construction to address these issues.

Figure 1 – Examples of pipeline strain demands from seismic, soil instability, discontinuous permafrost, and shallow water ice scouring scenarios.

The term strain-based design (SBD) has been adopted by the oil and gas industry to encompass pipeline design that addresses the loading conditions that impart stresses above the pipeline’s yield stress. It is important to note that traditional stress-based design considerations are followed as a baseline and would be augmented with additional requirements that are thought to assure target levels of longitudinal strain capacity in the pipeline for SBD. SBD is an area that is not currently addressed in all pipeline design codes, and when addressed it is often left to the designer to ensure a robust design with only general guidelines offered. The definition of the transition from stress to strain-based design is somewhat up for debate. There is general agreement that strains above 0.5% constitute SBD, however the region between traditional stress-based design utilization factors of 0.72 or 0.8 of the specified minimum yield stress (SMYS) and the 0.5% strain can be somewhat ill-defined in design codes.