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DEPARTMENT OF CIVIL AND RESOURCE ENGINEERING

TITLE OF THESIS:	LOW CYCLE RESPONSE OF DENTED PIPELINES SUBJECT TO CYCLIC AXIAL AND BENDING LOADS
TIME/DATE:	1:00 pm, Wednesday, November 15, 2017
PLACE:	Room 3107, The Mona Campbell Building, 1459 LeMarchant Street

EXAMINING COMMITTEE:

Dr. Markus Dann, Department of Mechanical Engineering, University of Calgary (External Examiner)

Dr. Gordon Fenton, Department of Engineering Mathematics, Dalhousie University (Reader)

Dr. Shawn Kenny, Dalhousie Adjunct Scholar, Associate Professor in Geomechanics and Associate Director of the Ottawa-Carleton Institute for Civil Engineering (Reader)

Dr. Farid Taheri, Department of Mechanical Engineering, Dalhousie University (Supervisor)

DEPARTMENTAL REPRESENTATIVE:	Dr. Hany El Naggar, Department of Civil and Resource Engineering, Dalhousie University
CHAIR:	Dr. William Currie, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

In the present thesis, the ratcheting and low cycle fatigue response of dented pipes undergoing quasi-static cyclic loads are investigated through a series of experiments conducted on small-scale pipe samples, and performing detailed nonlinear FE analysis. The investigation evaluated the response, and in-service life estimation of dented pipes undergoing inelastic cycles of axial, and bending loads.

Development of ratcheting strains in small-scale dented steel pipes subject to cyclic axial loads is investigated experimentally. It is observed that regardless of the nature of the applied loads, collapse of pipes loaded monotonically or cyclically would essentially occur at the same average strain level. The experimental results revealed that larger dent depths significantly affect the total number of cycles to failure; the number of cycles prior to collapse dramatically decreases by as much as 75% when the dent depth was increased by 2%.

Moreover, a nonlinear FEA framework is developed as an alternative and feasible approach for evaluation the load-bearing capacity of dented pipes under cyclic axial loads. A set of parametric FE analyses is performed to investigate the influence of mean stress, stress amplitude, loading regime and hardening-related parameters. It is concluded that the application of larger stress amplitudes (while maintaining the same peak stress) contributed to pipes earlier failure in comparison to the condition when pipes were subjected to a higher mean stress. It is also observed that the combined non-linear kinematic/isotropic hardening model is extremely sensitive to the material parameters used in describing the model.

Finally, the influence of dent depth on the evolution of pipe cross-section ovalization under a low number of curvature-controlled symmetric bending loads is investigated. Two empirical formulas are proposed for estimating the remaining in-service life of dented pipes. The first formula estimates the number of cycles causing the local instability of pipe's cross-section and consequently, initiation of fatigue cracks. The second equation predicts the variation of ovalization as a function of the applied loading cycles.