Abstract

The object of this Master thesis is the mechanical study of micro- and nano- structures and especially of one-dimensional structures in bending, buckling and compression. Those are structures characterized by having at least one of their dimensions in the nanoscale and microscale respectively. Nanoscale is defined as the scale in the order of the nanometer, one billionth of a meter (10^{-9} m). In a similar fashion, microscale is the scale in the order of the micrometer (10^{-6} m). Such one-dimensional structures are used increasingly in nanotechnology for application on micro- and nano- electromechanical systems (MEMS-NEMS), on biosensors etc. For this task the gradient theory of elasticity and the gradient theory of plasticity will be used.

The thesis is divided in two parts:

a) Study of the elastic deformation of beams subjected to bending and buckling (static and dynamic problems).

b) Study of the plastic deformation of pillars subjected to compression.

Each part includes theoretical study and application. In the theoretical study, after a brief historical review, some gradient elasticity/plasticity models are presented, as well as their solutions for specific loading types. In the scope of this study, a brief presentation of concepts of variational calculus which were used will be made. In application, models presented earlier will be employed for the interpretation and characterization of relative experimental measurements from the literature.

Among conclusions presented at the end, the emergence of internal length as an important natural quantity for the study of micro- and nano- structures is especially important. Internal length is associated with the internal structure and its use makes feasible the interpretation of a variety of behaviors and phenomena that could not be done by the classic elasticity/plasticity theory. The most notable example is that of size effects, effects that are characterized by mechanical behavior varying depending on the material dimensions. The combined use the theoretical models and experimental data can lead to measurements of the internal length.