Evaluating Measurement of Strain Hardening Method for Mechanical Assessment of Geomembrane Service Life in MSW Landfills

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ABSTRACT

The increased household production result in more construction of municipal solid waste (MSW) landfills and lagoons. One major part of these engineering projects is high-density polyethylene (HDPE) geomembrane. Geomembrane is an impermeable layer that used along bottom and sides of landfills and lagoons to contain the leachate and to protect the groundwater. Although of their chemicals resistance and high strength, it can be aged under service conditions such as high temperature, ultraviolet (UV) light, and chemicals exposure. These conditions accelerate oxidation of geomembrane and lead to brittle behavior and stress cracking which reduce its service life.

Our objective in this work is to properly evaluate and characterize HDPE geomembranes. The conventional method for evaluating geomembrane service life is the stress crack resistance (SCR) test in accordance with ASTM D5397. This method has many disadvantages such as time-consuming, expensive apparatus, and low repeatability of results. Recently, a new method has been standardized to characterize crack resistance of pipe resins from the slope of the curve of the tensile test at strain hardening region at high temperature. Few researchers have investigated this method for HDPE geomembrane. However, no standard has been approved yet for the method for geomembrane resins.

Thus, in this research, a series of tensile test at specific displacement rates have been performed for high-density polyethylene (HDPE) geomembrane at room temperature to study and standardize a method to measure strain hardening modulus. The proper displacement rate and measurement method have been specified based on data analysis. It is shown that low displacement rates are more acceptable to measure strain hardening modulus for geomembrane samples.

Another set of experimentations are also proposed to be performed for oven aged samples. The aim of this experiment is to study and verify the method of strain hardening modulus for aged HDPE geomembrane. However, several strain measurement problems are encountered while testing the aged samples. Most of the tensile testing data could not be recorded and thus not being able to obtain proper data to finally achieve representative strain hardening curve. Samples are retrieved periodically and kept in the dark for future work.

Finally, research has been conducted on how to overcome the limitations encountered during strain measurement using existing conventional methods. These limitations are successfully resolved, and we managed to obtain dependable strain hardening modulus throughout the entire testing range.