EXCELPLAS AND RED EARTH ENGINEERING TECHNICAL NOTE

Title: Stress Cracking Failure of HDPE Geomembranes Installed on Slopes without Compensation Slack and Without Adequate Geotextile Cushioning

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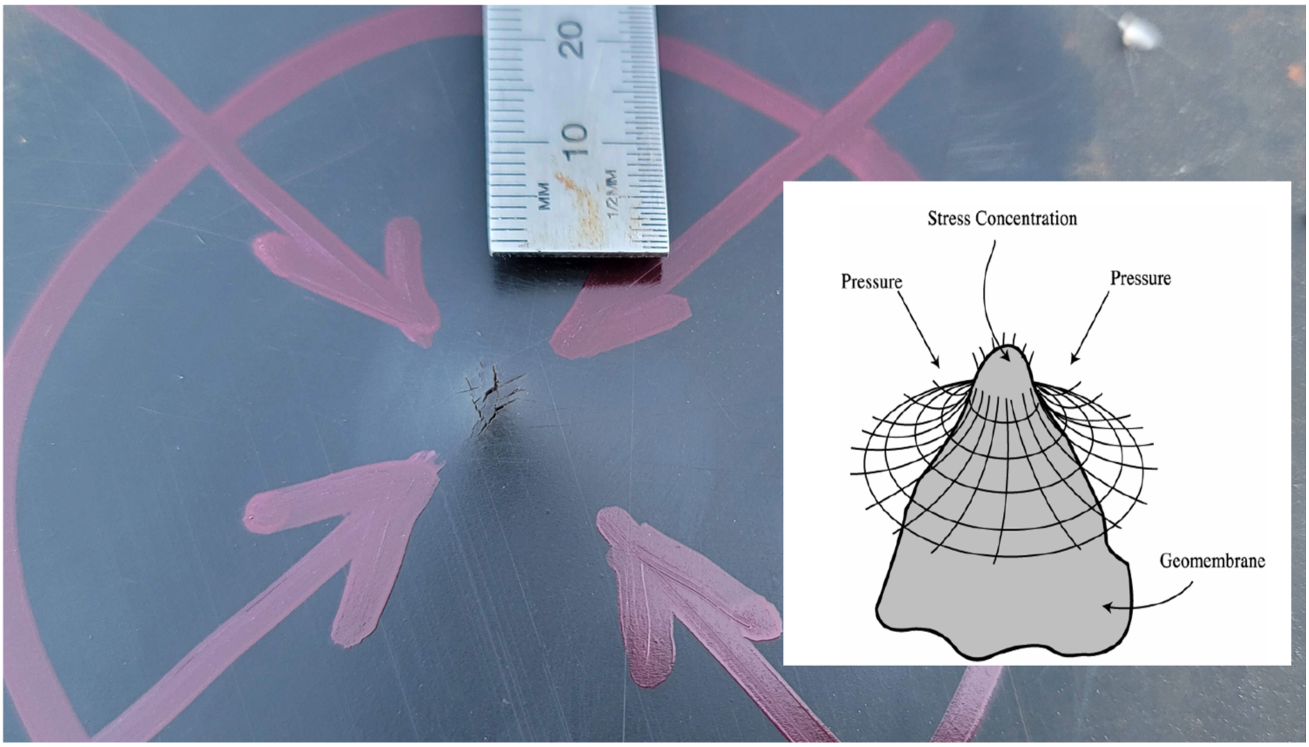
Abstract: This technical note investigates the impact of inadequate compensation slack and point loads on the stress cracking of HDPE geomembranes. The installation of HDPE geomembranes on slopes without compensation slack to compensate for thermal contraction during cooler nights can lead to excessive strains that can cause stress cracking.

The presence of underlying rocks and aggregate can exacerbate the situation by exerting point loads on the geomembrane, which can promote stress cracking. The stresses imposed by angular rocks and aggregate on the geomembrane are significant in the field situation. The concern, particularly with HDPE, is not whether the geomembrane is punctured but rather whether it is stressed sufficiently to induce stress cracking in the longer term. This technical note demonstrates that damage is done to the geomembrane well before a leak, hole, or puncture might occur in it.

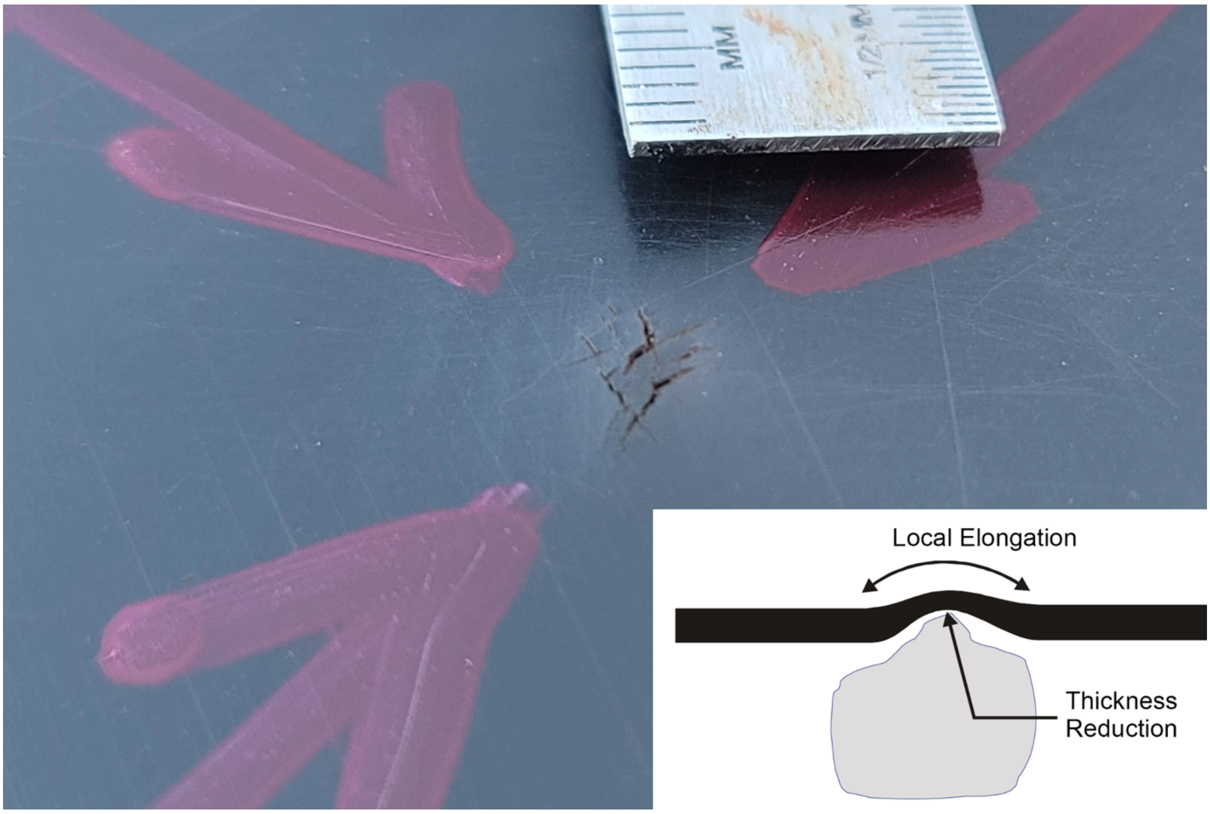
Introduction: High-density polyethylene (HDPE) geomembranes are used to prevent fluid migration in a variety of applications, including landfills, mining, and wastewater treatment. However, the installation of HDPE geomembranes on slopes without compensation slack can lead to excessive strains, which can cause stress cracking (see Photo 1 below).

The situation is exacerbated by the presence of underlying rocks and aggregate, which can exert point loads on the geomembrane and promote stress cracking. The puncturing stresses imposed by angular rocks and aggregate on the geomembrane are significant in the field situation. The concern, particularly with HDPE, is not whether the geomembrane is punctured but rather whether it is stressed sufficiently to induce stress cracking in the longer term (see Photo 2).



Localized Strain: When the geomembrane is stretched taught over an undulating subgrade and especially rocks and aggregate, this exerts considerable axisymmetric out-of-plane tension/applied stress in the geomembrane. This multiaxial stress manifests as localized stress concentrations where point loads from oversized aggregates are creating excessive surface strains that are inducing and promoting the development of stress cracking. The puncturing stresses on the geomembrane imposed by angular rocks and aggregate are significant in the field situation. Therefore adequate geotextile cushioning must be specified/used to reduce the magnitude and severity of the point loading on the geomembrane.

Stress Cracking: Stress cracking is a well-defined "sharp" cracking with a brittle failure mode characterized by no or nearly no elongation. Stress cracking in polyethylene is caused by sustained tensile stresses lower than the tensile yield stress of HDPE. The failures are manifested as localized stress concentrations where point loads from oversized aggregates are creating excessive surface strains that induce and promote the development of stress cracking. The concern is not whether the geomembrane is punctured, but rather whether it is stressed sufficiently to induce stress cracking in the longer term. Damage can be done to the geomembrane during installation that does not become a leak until much later.



Results and Discussion: The results of the study showed that lack of compensation slack and the presence of point loads can cause excessive localized strain, which can lead to stress cracking failure of the HDPE geomembrane. The point loads from oversized aggregates were found to be significant contributors to the development of stress cracking. The study demonstrated that damage can be done to the geomembrane during installation that does not become a leak until long after. This study emphasizes the importance of careful installation practices and the use adequate geotextile cushioning to minimize the risk of stress cracking in HDPE geomembranes.

Failure Mode: The stress cracking failure of HDPE geomembranes installed on slopes with compensation slack and underlying rocks is manifested as a well-defined "sharp" cracking with a brittle failure mode characterized by no or nearly no elongation. The damage is done to the geomembrane well before a leak/hole/puncture might occur in it. Excessive localized strain has caused stress cracking failure of the GMB due to aggregate point loading stresses.

Conclusions: In conclusion, this technical note investigated the impact of lack of compensation slack and combined point loads on the stress cracking of HDPE geomembranes. The study demonstrated that excessive localized strain caused stress cracking failure of the geomembrane due to aggregate point loading stresses. The study highlights the importance of careful installation practices and the use adequate geotextile cushioning to minimize the risk of stress cracking in HDPE geomembranes. The findings of this study have important implications for the design and installation of HDPE geomembranes in various applications, including landfills, mining, and wastewater treatment.