EXCELPLAS TECHNICAL NOTE: EP93

ISO 17025 ACCREDITED LABORATORY
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Title: Heat and UV Degradation of Exposed Bituminous Geomembranes (BGM) and Quantitative Assessment Using Multispectral 3D Imaging

Abstract:

Bituminous geomembranes (BGM) are widely used in various applications such as landfill liners, containment pond liners, and reservoir liners due to their excellent impermeability and durability. However, BGMs are susceptible to degradation when exposed to heat and UV radiation, leading to surface changes ranging from fine texturing to course features like elephant hide, alligator skin, and tortoise shell cracks. This paper discusses the surface changes that occur during early BGM degradation and presents a non-subjective method of quantitatively assessing BGM degradation using multispectral 3D imaging. The number and depth of cracks per unit area of BGM are accurately measured using this method, providing a useful and accurate index of the level of BGM degradation.

Introduction:

Bituminous geomembranes (BGM) are widely used as a barrier system to prevent the migration of liquids or gases in various applications, including landfill liners, containment pond liners, and reservoir liners. BGMs have excellent chemical and physical properties that make them suitable for these applications. However, when exposed to heat and UV radiation, BGMs undergo surface changes that can lead to degradation of their properties. These surface changes progress from fine texturing to course features like elephant hide, alligator skin, and tortoise shell cracks.

Heat and UV Degradation of BGM: When BGM is exposed to heat and UV radiation, it undergoes a series of crosslinking reactions and surface changes that reflect the degradation of its properties. The first stage of BGM degradation is characterized by fine texturing, which is barely visible to the naked eye. As the degradation progresses, the surface changes become more pronounced and visible. The second stage of BGM degradation is characterized by elephant hide cracking, which appears as a network of fine cracks on the surface of BGM, resembling the texture of an elephant's skin (see Figure 1). The third stage of BGM degradation is characterized by alligator skin cracking, which appears as interconnecting or interlaced cracks on the surface of BGM, resembling the hide of a crocodile (see Figure 2). The fourth stage of BGM degradation is characterized by tortoise shell cracking, which appears as very course interconnecting or interlaced cracks on the surface of BGM, resembling the shell of a tortoise.

Quantitative Assessment of BGM Degradation Using Multispectral 3D Imaging:

Multispectral 3D imaging provides a non-subjective method of quantitatively assessing BGM degradation. This method involves the use of a multispectral camera that captures images of the surface of exposed BGM at different wavelengths. The captured images are processed to generate a 3D model of the BGM surface, which is used to measure the number and depth of cracks per unit area of BGM. The data obtained from this method can be used to generate a useful index of the level of BGM degradation (see Figures 4 and 5).

Conclusions:

The degradation of BGMs due to heat and UV radiation is a significant concern for their long-term performance. The surface changes that occur during BGM degradation progress from fine texturing to course features like elephant hide, alligator skin, and tortoise shell cracks. Multispectral 3D imaging provides a non-subjective method of quantitatively assessing BGM degradation. The data obtained from this method can be used to determine the level of BGM degradation and to plan maintenance and replacement activities accordingly.

List of Figures

Figure 1. ‘Elephant Hide’ and ‘Alligator Cracking’ of Exposed and Heat Aged BGM

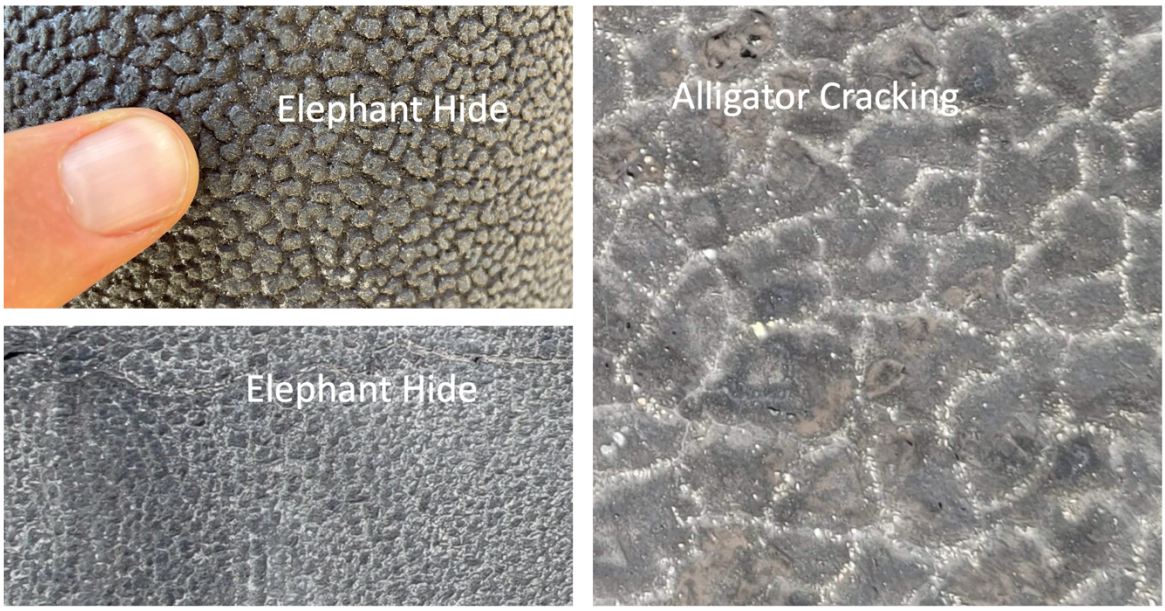


Figure 2. ‘Alligator Cracking’ of Exposed and Heat Aged BGM

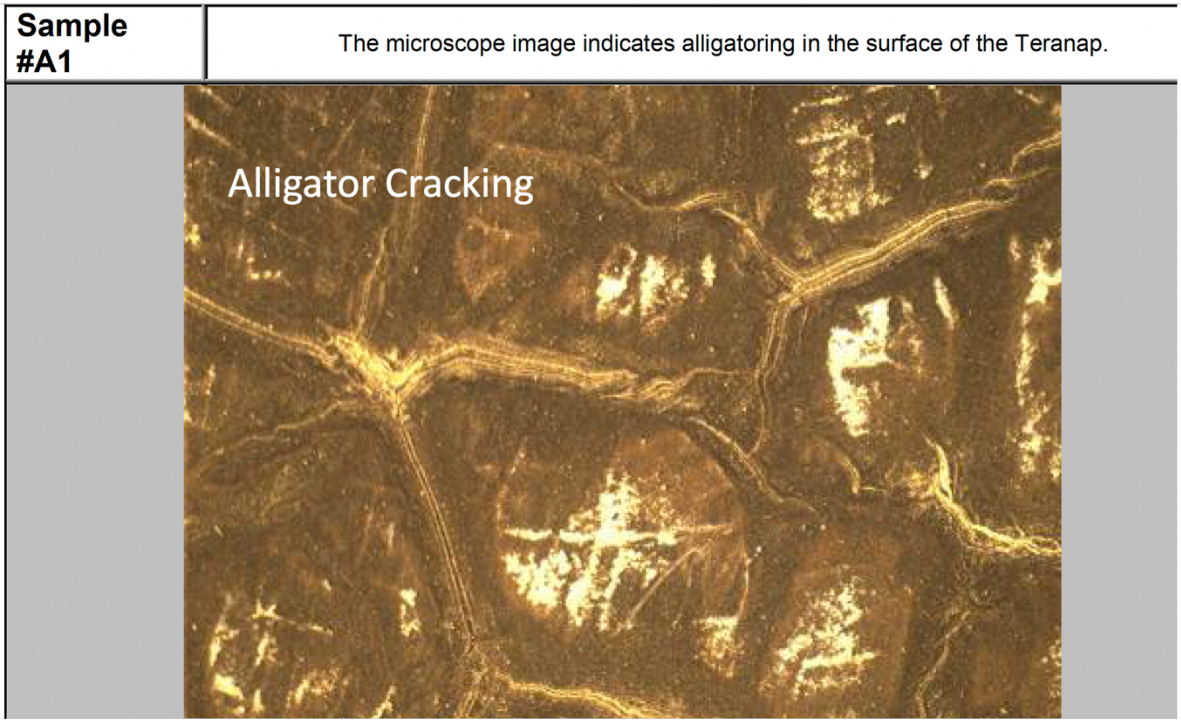
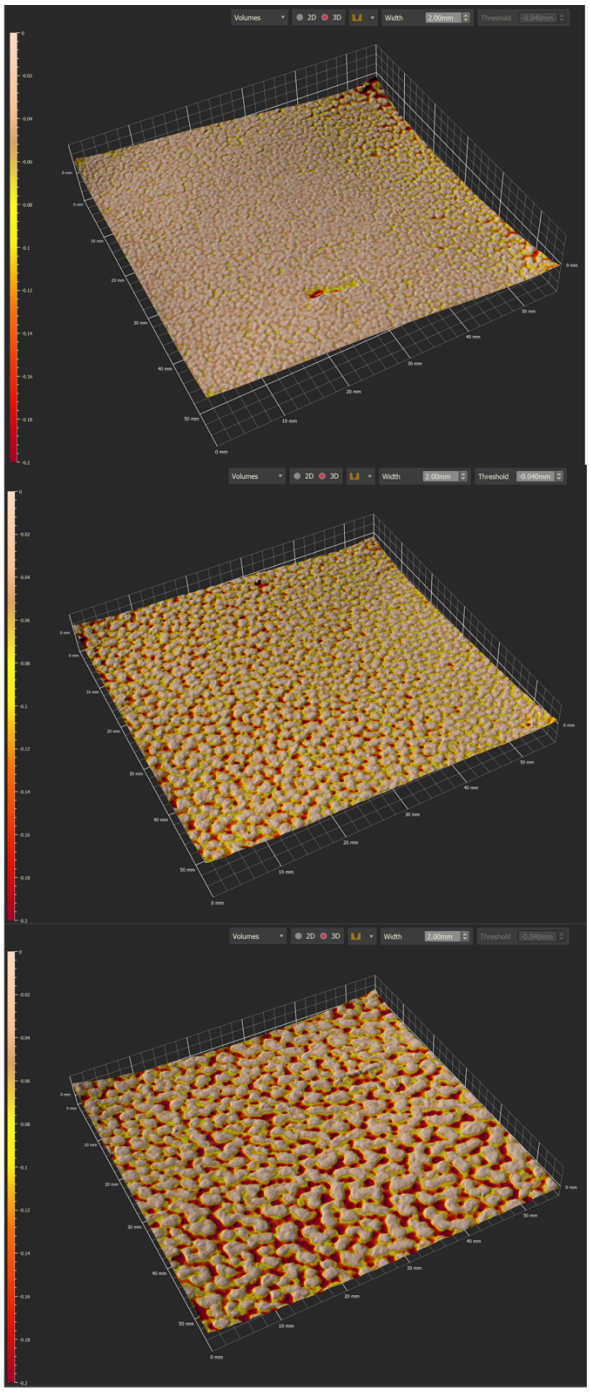


Figure 3. . ‘Alligator Cracking’ of Exposed and Heat Aged BGM

Figure 4. 3D Imaging of Progressive Degradation of BGM Surface



Progressive Degradation of BGM

Figure 5. 3D Imaging of Volume of Cracks with Progressive Degradation of BGM Surface