Compendium of Geomembrane Failure (2017)

Dr. John Scheirs
www.excelplas.com
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Cold Cracking of HDPE Geomembranes

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Case History

- Location: Kazakhstan
- Temperature: down to -30 to -35 deg.C
- Wind Speed: High (exposed area)
- Nature of Material: Exposed HDPE Geomembrane
- Thickness: 2 mm
- Application: mining application
- Details: liner was installed in May-June and cracked in winter time Dec-Jan (European winter)


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- Exposed HDPE geomembranes are susceptible to ***rapid crack propagation (RCP)*** under conditions of sub-zero temperatures combined with strong winds.
- Rapid onset of cold temperatures as well as strong gusting winds can combine to form conditions where rapid crack propagation (that is, crack advancing speeds of > 250 m/s) of HDPE can result leading to a **spontaneous shattering failure mechanism**.

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Multiple cracks


Multiple cracks

- Rapid Crack Propagation of exposed HDPE geomembranes can initiate at over-heated welds especially extrusion welds where S-OIT values of the liner have reduced to below 2 mins.
- In particular this can occur in areas of accumulated heat history where multiple extrusion beads have been placed on each other or close together or where extrusion beads intersect with wedge welds.


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- The localised recrystallisation of the HDPE and associated shrinkage stresses can set up the right circumstances for the formation of the initial stress cracks. These stress cracks can then propagate under particular environmental conditions of sub-zero temperatures and strong gusting, uplifting winds to cause widespread spontaneous HDPE geomembrane failure.
- This failure is characterised by the formation of long-shards of cracked geomembrane with the crack edges having a completely brittle appearance. Another important factor appears to be the rate of temperature drop which leads to the formation of damaging contraction stresses that place critical welds under rapid tension.


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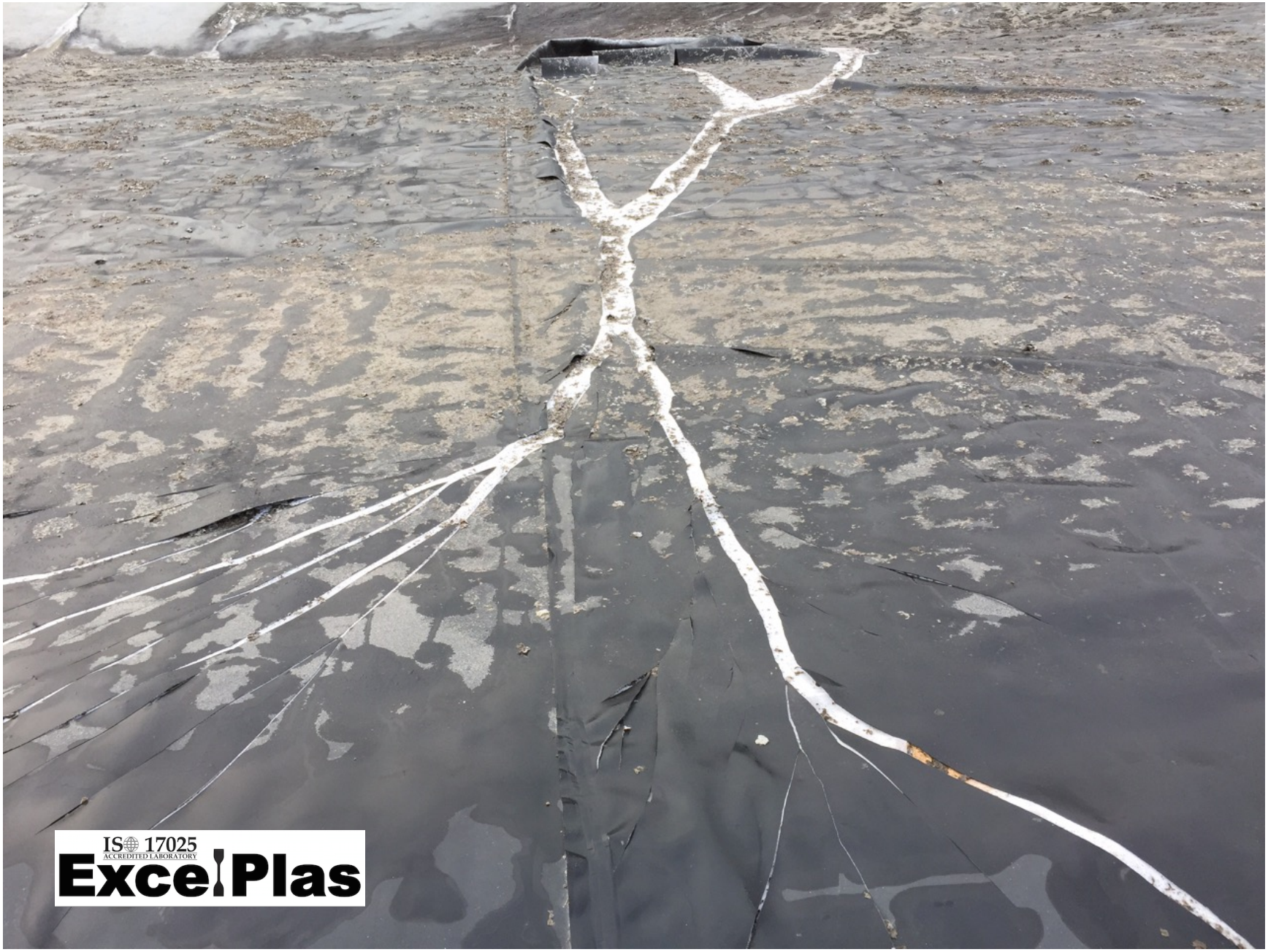
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Multiple cracks

- **Sub-Zero Cold Cracking of HDPE Geomembranes**

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- Exposed HDPE geomembranes are susceptible to rapid crack propagation (RCP) under conditions of sub-zero temperatures combined with strong winds. Rapid onset of cold temperatures as well as strong gusting winds can combine to form conditions where rapid crack propagation (that is, crack advancing speeds of > 250 m/s) of HDPE can result leading to a spontaneous shattering failure mechanism.
- RCP of exposed HDPE geomembranes can initiate at over-heated welds especially extrusion welds where S-OIT values have reduced to below 2 mins. In particular this can occur in areas of accumulated heat history where multiple extrusion beads have been placed on each other or close together or where extrusion beads intersect with wedge welds.
- The localised recrystallisation of the HDPE and associated shrinkage stresses can set up the right circumstances for the formation of the initial stress cracks. These stress cracks can then propagate under particular environmental conditions of sub-zero temperatures and strong gusting, uplifting winds to cause widespread spontaneous HDPE geomembrane failure. The failure is characterised by the formation of long-shards of cracked geomembrane with the crack edges having a completely brittle appearance. Another important factor appears to be the rate of temperature drop which leads to the formation of damaging contraction stresses that place critical welds under rapid tension.
- For more information on failure mechanisms of geomembranes contact: Dr. John Scheirs (john@excelplas.com)