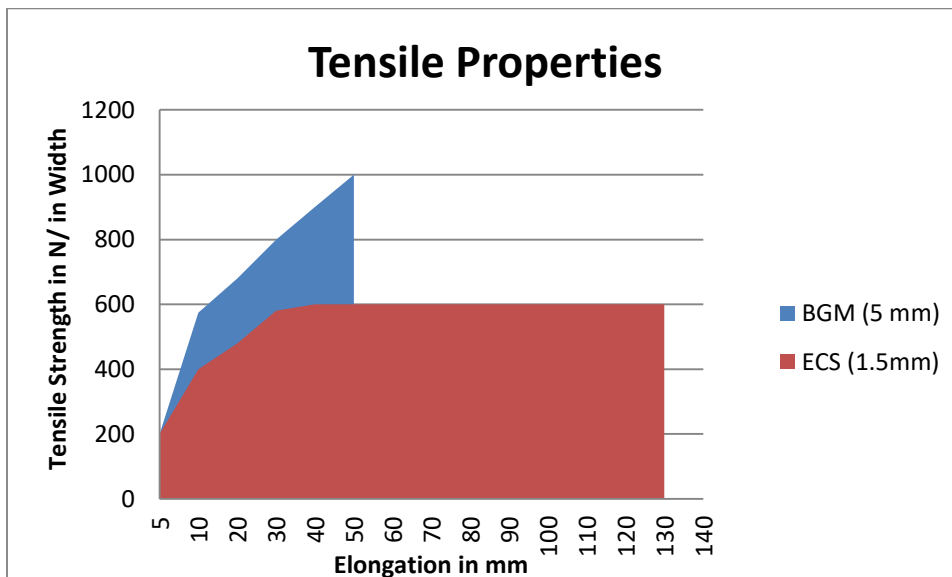




Comparison of Bituminous Geomembrane (BGM) and PRECIDIUIM™ ECS™ Polyurea

This testing was done using a 5 mm thick BGM and 1.5 mm PRECIDIUIM™ ECS™ Sprayed on Tytar Geotextile (as it would be installed in the field). Tensile properties of the two materials were measured by Quantum Technical Services Ltd. using ASTM D882, which utilizes a 1'' wide strip of material.

The toughness of a polymeric material, or its ability to maintain containment when stressed by external forces, is generally considered to be dependent on both the materials strength, and ability to stretch before breaking. Therefore, the area under the strength/elongation curve is defined as the toughness of the material. As shown below, while the BGM material had a higher strength at break than PRECIDIUIM™ ECS™, it did not elongate under stress nearly as far. A measurement of the areas under the respective curves gives a toughness value for PRECIDIUIM™ ECS™ over twice that of the BGM. PRECIDIUIM™ ECS™ provides more robust resistance to the sort of physical stresses encountered during installation and long-term service by combining an outstanding combination of strength, and ability to elongate without breaking.



Another measure of the robustness of a material, which is relevant to conditions faced in service, is impact resistance. The effect of cold service conditions must also be taken into account. Impact resistance was measured by a third party laboratory, CTT Group/Sageos in Montreal, according to ASTM D4226. The results are shown below; both materials were tested to failure at the four temperatures shown. In the case of the BGM, a 2 lb. weight dropped on the samples was sufficient to cause frequent brittle failure down to -40°C. The average total energy required to cause failure in the BGM was 0.1 to 0.3 joules. With **PRECIDIUM™ ECS™**, an 8 lb. weight dropped from considerable height was required to initiate failure down to -40°C and the total energy to cause failure averaged 10 to 23.8 joules.

ASTM D4226-16 Impact Resistance

BGM	Tests Completed	Brittle Failures	Ductile Breaks	Mean Failure Energy (Joules)	Falling Weight Used
-10°C	23	13	0	0.20	2 lbs.
-20°C	20	10	0	0.30	2 lbs.
-30°C	22	12	0	0.10	2 lbs.
-40°C	20	10	0	0.30	2 lbs.
ECS					
-10°C	21	8	3	15.7	8 lbs.
-20°C	20	10	0	20.90	8 lbs.
-30°C	21	2	8	23.8	8 lbs.
-40°C	23	1	11	10.0	8 lbs.

In summary,

- **PRECIDIUM™ ECS™** applied to Typar proved to be the more durable material. In service, even under harsh winter conditions, **PRECIDIUM™ ECS™** will be more difficult to stress to failure.
- This will make it more resistant to external forces such as protrusions in the subgrade, backfilling during winter construction, animal hooves and other foreseeable in-service hazards.
- **PRECIDIUM™ ECS™** is a spray-applied membrane and the Typar Geotextile is pre-sprayed robotically before delivery to site. Large panels of **PRECIDIUM™ ECS™** membrane are deployed and joined in the field, so there is an installation advantage over BGM which requires more seaming.
- **PRECIDIUM™ ECS™** can be installed in cold weather, making winter installation a viable option.