

ESPECIFICACIONES DE LOS MATERIALES

GCL

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ESPECIFICACIONES

DE LOS

MATERIALES

GCL

TECHNICAL DATA SHEET

Bentoliner® SPL® 4000/100/200

Bentoliner® SPL 4000/100/200 is a composite needle punched GCL. Consists of woven and nonwoven geotextiles sandwiching sodium bentonite granules. The bentonite is > 80% by weight sodium activated bentonite.

Properties of Geotextile	Test Method	Frequency	Value
Carrier Layer - Woven	AS 3706.1	1/20,000 m ²	> 100 g/m ²
Cover Layer - Nonwoven	AS 3706.1	1/20,000 m ²	> 200 g/m ²

Properties of Bentonite	Test Method	Frequency	Value
Montmorillonite Content	X-ray diffraction	1/50 tonnes	≥ 75%
Swell Index	ASTM D 5890	1/40 tonnes	≥ 24 mL/2g
Fluid Loss	ASTM D 5891	1/40 tonnes	≤ 18 mL (max.)
Cation Exchange Capacity	Methylene Blue Test	1/50 tonnes	≥ 70 meq/100g (typ.)
Carbonate Content	XRD	1/50 tonnes	≤ 2 wt% (typ.)
Moisture Content	ASTM D 5993	1/4,000 m ²	≤ 10% (typ.)
Particle Size Passing 0.2 to 2mm Screen	AS 1289.3.6.2	1/40 tonnes	> 90% (typ.)

Properties of GCL	Test Method	Frequency	Value
Mass per unit area of bentonite ⁽¹⁾	ASTM D 5993	1/4,000 m ²	≥ 3700 g/m ²
Mass per unit area of GCL ⁽¹⁾	ASTM D 5993	1/4,000 m ²	≥ 4000 g/m ²
Moisture content	ASTM D 5993	1/4,000 m ²	≤ 10% (max.)
Tensile Strength MD	ASTM D 6768	1/4,000 m ²	≥ 8.0 kN/m
Permeability	ASTM D 5887	1/10,000 m ²	≤ 3.0x10 ⁻¹¹ m/s (typ.)
CBR Burst Strength	AS 3706.4	1/4,000 m ²	≥ 1,600 N
Tensile Elongation @ break	ASTM D4595	1/4,000 m ²	≥ 10%
Internal Shear Strength 10 kPa	ASTM D 6243	Periodic	30 kPa (typ.)
Internal Shear Strength 30 kPa	ASTM D 6243	Periodic	50 kPa (typ.)
Peel Strength	ASTM D 6496	1/4000 m ²	≥ 360 N/m

Standard Roll Dimensions	Test Method	Frequency	Value
Width x Length	Typical	Every roll	5.0 m x 30 m
Quantity	Typical	Every roll	150 m ²

Notes

⁽¹⁾ at 0% moisture content

Properties are MARV values unless stated otherwise. Derived from standard tests and are subject to usual product variation. The right is reserved to make changes without notice at any time.

Consult Polyfabrics Australasia or a certified Engineer for site specific installation instructions. Polyfabrics Australasia reserves the right to change its product specification at any time. It is the responsibility of the specifier and purchaser to ensure that product specifications used for design and procurement purposes are current and consistent with the products used in each instance.

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Bentoliner® Geosynthetic Clay Liner (GCL) Range

DEPLOYMENT:

The roll of Bentoliner® is supported during its deployment so that the fabric designated as the upper surface faces out, away from the installation vehicle (refer to installation guidelines). The free end of the roll can then be secured (installers standing on edge) and the vehicle supporting the roll can slowly back away, deploying the Bentoliner® as it moves. Alternatively, the free end can be manually pulled across an area to be lined by the installation crew while the equipment simply suspends the roll.

Bentoliner® should be covered by a minimum thickness of 300mm of approved soil or gravel at the end of the construction day.

Seaming and Joining: Bentoliner® seams are constructed by overlapping adjacent panel edges and ends by 300mm - 600mm. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Bentoliner® BL100 has Supergroove® and requires no longitudinal lap treatment

ANCHORAGE:

Bentoliner GCL is typically anchored in a trench around the perimeter of the containment basin to provide the required pullout resistance. The size and shape of the trench, as well as the appropriate backfill procedures should be in accordance with the project drawings and specifications.

Bentoliner® should be placed in the trench extending down the inside wall face and along the entire trench floor, secured by the controlled placement and compaction of backfill into the trench prior to placing cover soil on the slopes.



Consult Polyfabrics Australasia or a certified Engineer for site specific installation instructions. Polyfabrics Australasia reserves the right to change its product specification at any time. It is the responsibility of the specifier and purchaser to ensure that product specifications used for design and procurement purposes are current and consistent with the products used in each instance.

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The first specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the upper left corner of the page. The second specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the upper middle of the page. The third specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the upper right of the page. The fourth specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the lower left of the page. The fifth specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the lower middle of the page. The sixth specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the lower right of the page.

The seventh specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the lower left of the page. The eighth specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the lower middle of the page. The ninth specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the lower right of the page. The tenth specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the lower left of the page. The eleventh specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the lower middle of the page. The twelfth specimen is a small, dark, irregularly shaped object, possibly a fossil or mineral specimen, mounted on a light-colored background. It is located in the lower right of the page.

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STORAGE AND INSTALLATION QA CHECK LIST

1. Introduction

The following check lists are provided for the application of Geosynthetic Clay Liners (GCLs) for both stand-alone liners and when used as one component of composite liners, for the assistance of contractors and installers. Specific and individual site conditions will vary from those presented herein.

Polyfabrics Australasia Pty. Ltd. (PA) reserves the right to review the suitability of this material for any particular application. In that regard, should any unique or unusual conditions exist, PA should be contacted to provide any guidance or recommendations, to ensure that operations in no way damage the Bentoliner or otherwise compromise the performance of the material.

2. MQA

For MQA refer to separate document "POLYFABRICS GCL MANUFACTURING QUALITY ASSURANCE AND QUALITY MANUAL" Located in Appendix A.

For a typical MQA documents refer to Appendix B.

3. Shipping, Handling, and Storage

Bentoliner GCLs are shipped in rolls, which are protected by a plastic cover material. Nevertheless, during all stages of shipping, handling, and storage of these materials, care must be taken to prevent puncturing or other damage to the rolls, and to protect against wetting of the rolls. Under no circumstances should Bentoliner be dragged, lifted by one end only, rolled off flat truck or unloaded in a fashion that could damage the roll. The Bentoliner rolls should be stored on site in a secure location that will minimize the exposure to dirt or potential damage due to the proximity of working equipment, vandalism, etc.

Ensure that they are stored no greater than 4 rolls high in a flat, hard, dry, stable and free draining storage location is provided to store the rolls flat and continually supported.

In some cases, rolls can be marshaled at various locations to minimize transit distances and delays during deployment. In general, storage of materials at all times should provide protection of the rolls from equipment or other handling-related damage, precipitation, and surface accumulations of water. Protective coverings should only be removed immediately prior to deployment of materials.

STORAGE AND INSTALLATION QA CHECK LIST

Due to the nature of the product and its mechanism of function, any rolls of Bentoliner that are exposed to precipitation or are otherwise wetted should be set aside for examination by the Engineer and the Installer to establish the degree of damage. Prior to deployment, any rolls of Bentoliner that become contaminated with foreign materials shall be examined to ensure that the material has not been compromised. In some cases, the material may be salvaged, but significant wetting of the Bentoliner may complicate or even impede deployment and the normal course of action should be that the material is discarded.

PACKAGING, TRANSPORTATION AND UNLOADING ON SITE

		YES	NO
Documents	= Delivery Docket	☐	☐
	= QA	☐	☐
	= MSD	☐	☐
Method of transportation to site	= Closed Container	☐	☐
	= Covered Trailer	☐	☐
	= Flatbed Truck	☐	☐
Method of unloading	= Spreader Bar	☐	☐
	= Carpet Prong	☐	☐
	= Slings at 1/3 points	☐	☐
Any visible sign of roll damage	=	☐	☐
Roll packaging impervious to moisture	=	☐	☐
Storage in well drained leveled area	=	☐	☐



Unloading from Closed Container using a Carpet Prong attachment

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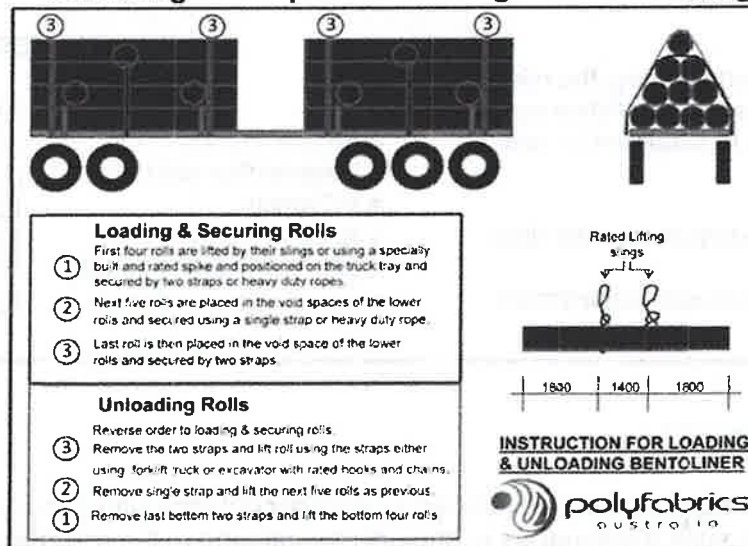
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STORAGE AND INSTALLATION QA CHECK LIST



Unloading from Open Truck using Forklift and Sling



Instructions for Loading, Unloading and Securing Rolls from Flat Bed Truck

4. Site and Subgrade Preparation

In cases where Bentoliner is to be deployed directly over soil materials, the surfaces should be cleared of all vegetation. In addition, all roots, debris, large (>25mm diameter) rocks, or other foreign materials at the surface of the subgrade, should be removed.

The subgrade should be graded and compacted in accordance with the Engineer's specifications, but in any event, should be compacted to at least 90 per cent of Modified Proctor maximum dry density (ASTM D1557). The final surface should be smooth – if compaction equipment with kneading lugs is employed, the final surface should be scarified to the lug holes, and finished with a smooth-drum compactor. Alternatively, a leveling layer of sand or fine soil can be used.

STORAGE AND INSTALLATION QA CHECK LIST

The condition (including testing) of the underlying soil should be confirmed prior to placement operations. The Engineer should prepare the appropriate documentation for the subgrade surface and certify or otherwise approve the condition of this prepared surface prior to the deployment of any Bentoliner.

Similarly, the Installer should ensure that all repairs have been made to any underlying layer(s) of geosynthetics prior to placement of Bentoliner. The Installer should also ensure that the Engineer has verified the completion of the underlying layers and has approved the areas for deployment of the material.
If however the subgrade can't meet these requirements consideration should be given to the use of cushion geotextiles (refer to Technical note on cushion geotextiles)

<u>Site and Subgrade Preparation</u>		YES	NO
Does the surface meet the minimum standard as per installation requirement =		☐	☐
Anchorage requirement for wall	= Anchor Trench	☐	☐
	= Material Run out Length	☐	☐
	= V-Trench	☐	☐
Anchorage requirement for floor	= Anchor Trench	☐	☐
	= Material Run out Length	☐	☐
Cushion geotextile requirement.	=	☐	☐

5. Deployment

Bentoliner materials should be deployed in strict accordance with good construction practice and in such a manner as to prevent any damage to the materials. In particular, the Installer and the Engineer should meet on site prior to the placement of any material, to ensure that these guidelines are generally followed and that the deployment orientation is consistent with the Engineer's design, and the project drawings.

The Installer should outline the methods of deployment of the Bentoliner materials to be used. Considerable freedom is available to the Installer in this regard, provided that the methods employed do not in any way damage the materials or any other soil. Procedures shall be discussed for acceptability during the pre-construction stage, and the agreed procedures documented at that time.

Prior to the placement of any Bentoliner materials, the Installer may marshal rolls in various locations so as to facilitate deployment. Particular emphasis should, however, be made for the requirement to keep these rolls dry at all times.

Prior to, during, and subsequent to deployment, the Installer should ensure that:

- Bentoliner is deployed using a rated purpose build dispenser or Spreader Frame.
- Deployment should always be from the highest point to the lowest;




STORAGE AND INSTALLATION QA CHECK LIST

- On slopes, deployment should be down, not across the slope;
- Bentoliner should be cut using approved cutters, and care taken to ensure that materials underlying them are not damaged during cutting; and
- Bentoliner should be kept as clean as possible at all times up to and including the time of placement of the next layer of material covering them.

Bentoliner Dispenser Brief Description

It comprises of a load spreading beam suspended by an A chain having a capacity greater than 2000kg.

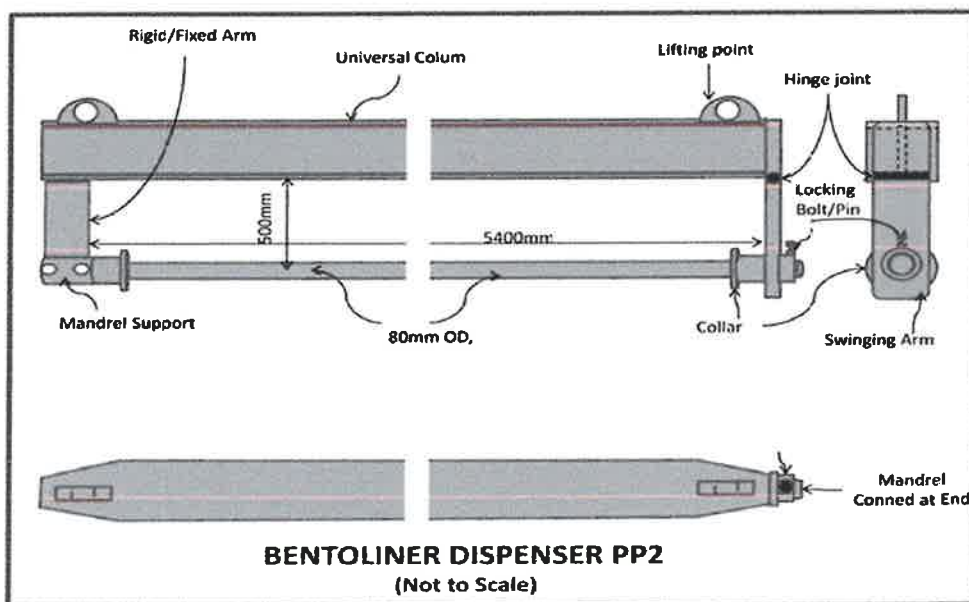
The beam has suspended arms:

1. Rigid Arm that holds the mandrel
2. Hinged/Swinging Arm that supports the other end of the mandrel.

The mandrel has two cone end plates that fit on either end of the Bentoliner roll to stop the roll from drifting along the mandrel.

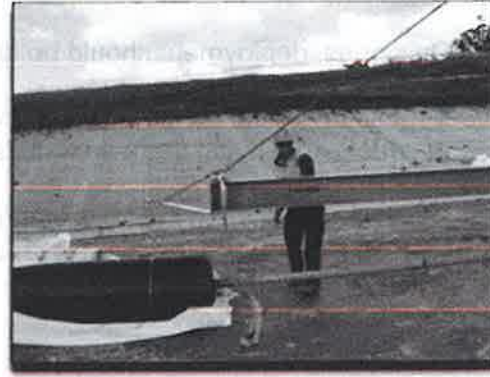
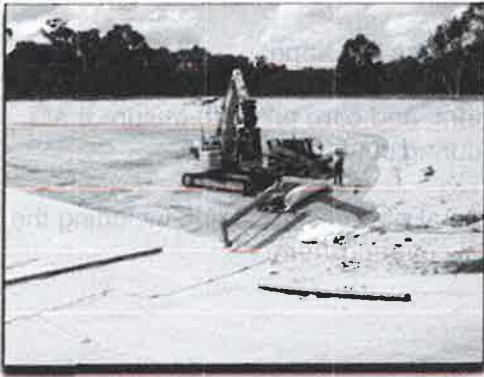
The rolls must not be lifted without the hinged arm secured on the mandrel.

The Bentonite Dispenser is designed to simplify installation and to eliminate man-handling of the heavy dispenser components during the loading of the Bentoliner rolls and the removal of the roll core.





STORAGE AND INSTALLATION QA CHECK LIST



Loading Roll using Bentoliner Dispenser PP2



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Induction and Risk Assessment on the use of Bentoliner Dispenser PP2

STEP	WHAT ARE THE BASIC STEPS	POTENTIAL HAZARDS	HAZARD CONTROLS
1.	Brief all personnel on OH&S Issues.	Incorrect procedures being followed.	Wear High Visibility vest, hard hat safety boots, safety sun glasses, gloves, long trousers
2.	Ensure all the lifting equipment is in good order and the chains are not twisted, are of equal length and spacing on the spreader beam and correctly attached to the machine.	Injury to personnel	One personnel to act as a look out and to provide clear signals and instructions to the driver at all times.
3.	Guide mandrel into Bentoliner core using machine arm	Injury to personnel	Keep clear until mandrel protrudes.
4.	Before lifting the roll, secure the hinged arm to the mandrel and insert pin.	Damage/Shearing of mandrel	Make sure pin is secured
5.	Bentoliner roll secured close to ground.	Uncontrolled unravelling of roll	Keep close to the ground.
6.	Rise machine arm	Lifting too fast / tangle chains Uncontrolled dispensing of panel.	Rise in controlled manner with no personnel to go under lifted roll. Do not cut roll tape (around roll) until roll is in position and
7.	Move roll into start position.	Roll/frame jerking and swinging – injury to personnel.	Keep personnel clear, or use guide ropes so personnel can minimize roll swinging without standing beneath or near the suspended roll
8.	Place roll into position.	Lowering onto personnel.	Roll must be positioned and grounded.
9.	Deployment.	Sliding of dispensed material across the subgrade and 'up-ending' following behind on di	Deploy at no faster than walking pace.
10.	Once roll is deployed, remove core from mandrel in a reverse order to 3 and 4.	Lowering onto personnel.	Keep clear from machine arm and frame using the guided ropes

In general, material deployment should not be carried out during any form of precipitation, in the presence of excessive moisture (e.g., fog or dew), in an area of stagnant water, or during periods of high winds. In addition, in the usual instance when these materials are to be covered by geomembrane or soil materials, only as Bentoliner should be deployed in a given shift as can be covered by geomembrane or soil in that shift. This will minimize the potential exposure of material to poor weather conditions.

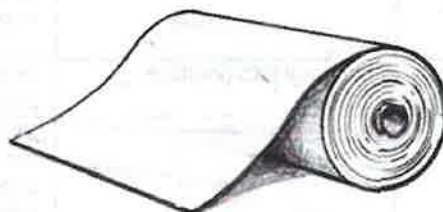
STORAGE AND INSTALLATION QA CHECK LIST

Bentoliner Deployment		YES	NO
Site Induction for all site personnel =		☐	☐
Risk analysis – SWMS =		☐	☐
Installation Equipment =	Excavator	☐	☐
	All terrain extendable forklifts	☐	☐
	Spreader Frame/ Dispenser	☐	☐
	Posy track	☐	☐
	Bentonite granules or Paste	☐	☐
	Trowel	☐	☐
	Carpet knives	☐	☐
	Broom	☐	☐
Roll orientation required =		☐	☐

The roll of Bentoliner is supported during its deployment so that the fabric designated as the upper surface faces out (natural orientation), away from the installation vehicle. The free end of the roll can then be secured (installers standing on edge) and the vehicle supporting the roll can slowly back away, deploying the Bentoliner as it moves. Alternatively, the free end can be dragged by a light vehicle such as a Positrack or manually pulled across an area to be lined by the installation crew while the equipment simply suspends the roll. The later methods are used to avoid surface damage caused by the installation vehicle.



(a) Unrolled "Natural" orientation



(b) Unrolled from top



Bentoliner should be covered by a minimum thickness of 300 mm of approved soil or gravel at the end of the construction day.

STORAGE AND INSTALLATION QA CHECK LIST

5. Lapping and Joining

GCL seams are constructed by overlapping adjacent panel edges and ends. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.



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STORAGE AND INSTALLATION QA CHECK LIST

The Bentoliner has self-seaming capabilities in their longitudinal overlaps due to the 300mm pre-coated edging strips. For pond applications, supplemental bentonite must be used in all longitudinal seams.

Panels of Bentoliner should be joined in accordance with the following requirements:

- Adjacent panels must be overlapped a minimum of 300 mm to 600mm along the side joints, and 600 mm at end joints;
- Applications for which Bentoliner comprises the bottom component of a Geomembrane/GCL composite liner, other than the required overlap, no further treatment of the joints is recommended;
- Whenever Bentoliner GCLs are employed as the sole component of a liner (standalone liner), the properly overlapped joints should be further treated by the addition of powder bentonite or granular bentonite (i.e. sodium Bentonite as used inside the product);
- Special applications in which Bentoliner is deployed underwater, the required overlap for all edges is 1000 mm, with no further treatment of the joints required; and,
- When more than one layer is installed by stacking, the joints shall be staggered, where possible.
- In locations where stacking of Bentoliner is required, each layer should be deployed at right angles to the underlying layer.



Seaming Bentonite Granules placed on Bentoliner EB (a) using dispenser or (b) using plastic watering bucket

STORAGE AND INSTALLATION QA CHECK LIST



Seaming Bentonite Paste used on transverse joins

Lapping and treatment Requirement

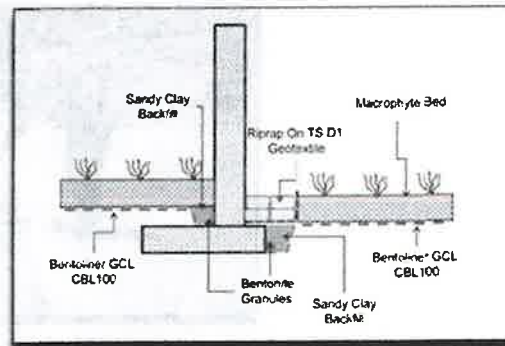
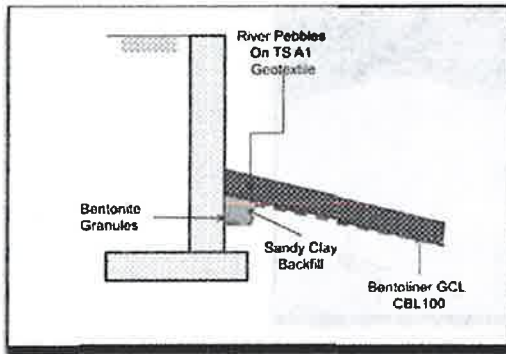
		YES	NO
Additional Joint treatment required		☐	☐
	= Granules	☐	☐
	= Paste	☐	☐
Lapping Requirement	= Standard lapping	☐	☐
	= Special lapping	☐	☐

6. Penetrations & Terminations

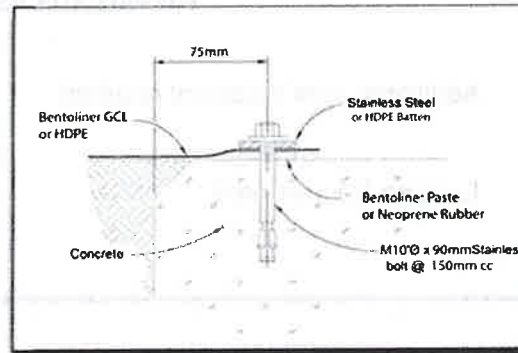
Conventional sealing of penetrations including concrete footings, walls, rock abutments and termination points are totally reliant on the confining pressure of the cover placement. This is classified as a soft option. The interface between the GCL and the surface is treated with additional Bentonite granules or Bentonite paste prior to confining pressure applied.

If in the case during the life of the project this confining pressure is removed due to erosion etc. a more structural option should be used such as stabilizing the surrounding soil with cement or lime or in the case of preformed concrete walls and footings, a more rigid option can be used such as gluing or using HDPE or Stainless Battens and bolting.

STORAGE AND INSTALLATION QA CHECK LIST



Soft Option Termination



Rigid termination

Termination

Conventional Termination (soft option) =

Rigid Termination =

YES

NO

☐
☐
☐
☐

7. Anchorage

At the perimeter of the installation, as well as at the top of slopes, Bentoliner should be anchored into a trench. This anchor trench should be located at least 600 mm beyond the crest of the slope, and should be a minimum of 450 mm deep. Bentoliner should be placed into this trench extending down the inside face secured by the controlled placement and compaction of backfill into the trench in such a manner as to not damage the composite. When installed in conjunction with other geosynthetics, the same anchor trench can be used to secure all of the geosynthetics, provided that some vertical separation is provided between layers in the trench, by layers of the backfill soil.

STORAGE AND INSTALLATION QA CHECK LIST



Standard Anchor Trench



V-Trench



Horizontal Trench

In all cases, appropriate anchorage should be provided to prevent the ingress of any surface runoff beneath the Bentoliner, in addition to securing the GCL for stability and performance during loading and long-term.

	<u>Anchorage</u>	YES	NO
Standard trench	=	☐	☐
V-trench	=	☐	☐
Horizontal predetermined length	=	☐	☐

8. Cover Placement.

Provide cover soils that are free of angular stones or other foreign matter that could damage the GCL. Cover material for use in placing on top of GCLs is to consist of hard, durable, clean sand, gravel, crushed stone or other material specified on the plans, and that is free from organic matter, clay balls, or other deleterious matter. Unless otherwise shown on the plans, crushed limestone will not be permitted. Cover soils with high concentrations of calcium (e.g., limestone, dolomite) are not acceptable.

Typical gradation for cover material is shown in Table below by percent composition of weight.

STORAGE AND INSTALLATION QA CHECK LIST

Typical Gradation for Cover Material

COVER MATERIAL COMPOSITION	
SIEVE SIZE	% RETAINED ON SIEVE
3/4 in.	0
3/8 in.	10-20
No. 4	5-20
No. 8	5-20
No. 100	10-20
No. 200	10-20
< No. 200	< 5

The cover soil thickness should be at Least 300mm or approximate 6kPa of confining pressure.

If the cover material doesn't meet these requirements consideration should be given on the use of a cushioning layer of finer soil that meets the requirement and coarser material on top.

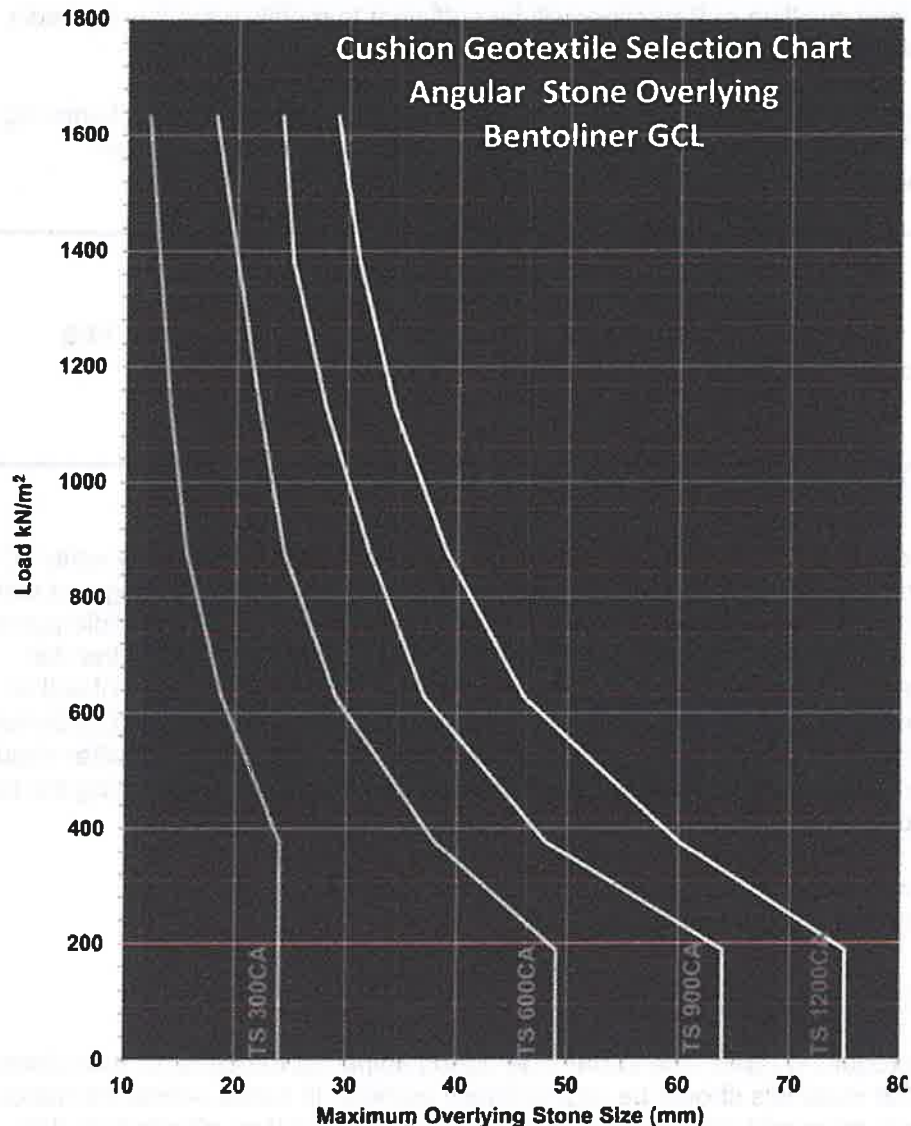
Alternative design a cushion geotextile to protect the GCL (refer to Technical note on cushion geotextiles)

Only the amount of Bentoliner® that can be anchored, inspected, and covered should be installed the same day. It should be covered with the specified 300 mm thickness of cover topsoil immediately following deployment. The soil cover should be placed within 800 mm of the leading edge of the Bentoliner®. The leading edge can then be covered with plastic sheeting that is folded under the exposed edge approximately 300 mm. Sand bags or suitable ballast should be placed on the protected liner to hold the plastic in place and to partially confine the Bentoliner®. The next morning the ballast and the plastic can be removed and subsequent rolls of Bentoliner® placed as described in Section 4. In dual lining (GCL/HDPE) systems when the Bentoliner is used as a secondary liner

Cover Placement		YES	NO
Soil cover meets requirements	=	☐	☐
Cushion Layer	= Sand	☐	☐
	= Cushioning Geotextile	☐	☐
Dual Lining System	=	☐	☐



STORAGE AND INSTALLATION QA CHECK LIST



9. Hydration

Bentoliner GCLs are supplied with deliberate partial hydration of up to 30%. This has no affect on its mechanical properties and is designed to assist in the dust management and help performance in the short term especially when installed in dry subgrade or in the case of evaporation ponds with high ionic strength in the brine.

Whenever Bentoliner is employed as the bottom component of a geomembrane / GCL composite liner, pre-hydration of Bentoliner should not be undertaken.

Whenever Bentoliner comprises a single component liner, it should be hydrated after installation. As the bentonite swells upon the addition of water, this should be accomplished after the placement of the cover soils, wherever feasible, to confine the material and inhibit any potentially deleterious swelling. The resulting controlled

STORAGE AND INSTALLATION QA CHECK LIST

hydration and swelling of Bentoliner will be sufficient to mobilize the low hydraulic conductivity of the material.

In most single liner application, the containment fluid is acceptable as a hydrating medium. Engineers are encouraged to contact PA to determine hydration requirements.

<u>Pre-Hydration</u>			
		YES	NO
Additional pre-hydration	=	☐	☐

10. Protection

Swelling of the bentonite layer occurs when the material is contacted by water. Care should be taken to avoid the exposure of Bentoliner to precipitation, stagnant water, or any other source of water prior to placement and cover. Although needle punching provides some protection from unconfined swelling, it is recommended that full hydration be avoided prior to cover soil placement. This overlying layer of soil or geosynthetics should be placed within the same shift as the deployment of Bentoliner. Should this immediate covering not be possible for any reason, the Installer should take appropriate measures to prevent the wetting of the composites during the period of exposure.

Alternatively, the use of Bentoliner with the membrane up will provide temporary protection from precipitation.

11. Damage and Repair

All areas requiring repair due to damage during shipping, handling, or manufacturing flaws in the materials should be appropriately marked. In cases where the material is pervasively damaged and repair is impractical, the material so affected shall be marked accordingly, removed, and set aside or removed from the site so as to avoid use.

All repairs made by the placement of a patch of the same material over the flaw or damaged area should extend at least 300 mm beyond the flaw or damage in every direction. Further, a bead of granular bentonite shall be placed between the patch and the original Bentoliner, similar to the overlap treatment



Reservorio.

GEOCOMPUESTO DE ARCILLA - GCL

El GCL es un geocompuesto de arcilla, que combina dos capas exteriores de geotextil con un núcleo uniforme de arcilla natural de bentonita de sodio, cuyo propósito es formar una barrera hidráulica. Nuestro GCL resulta ser una solución superior y más económica que sustituye a una gruesa capa de arcilla natural compactada. Se produce mediante la distribución de una capa uniforme de la bentonita de sodio entre dos capas de geotextiles. Todo el geocompuesto es punzonado con aguja. Este proceso resulta en una unión mecánica fuerte entre las telas. Un proceso de tratamiento con calor patentado se utiliza luego para mejorar la fijación de las fibras punzonadas con agujas en su lugar. Las propiedades incluyen una mayor resistencia al corte interno y resistencia a la fluencia a largo plazo.

APLICACIONES

- Rellenos sanitarios.
- Pads de lixiviación.
- Estanques de aguas pluviales de gestión.
- Estanques recreativos.
- Impermeabilización de rellenos sanitarios.
- Impermeabilización de presas y diques.
- Contención secundaria para los tanques por encima del suelo.

VENTAJAS

- Muy eficaces como una barrera hidráulica, incluso en condiciones de alto gradiente.
- Menor tiempo y costo de instalación que una capa de arcilla natural compactada.
- No requiere sellado ni uniones, sólo un traslape.
- No requiere protección adicional con geotextiles.

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Traslado de rollos GCL.



Tendido de GCL.



202 - ALPHA 30 QTZNR01092

Figure 1. A photograph of a sample of the material being tested. The sample is a small, irregular, light-colored piece of material, possibly a mineral or rock, with a rough, crystalline texture. It is set against a dark, textured background. The sample is oriented diagonally, with its longest edge running from the top-left towards the bottom-right. The lighting highlights the surface irregularities and the internal structure of the material.

The sample is a small, irregular, light-colored piece of material, possibly a mineral or rock, with a rough, crystalline texture. It is set against a dark, textured background. The sample is oriented diagonally, with its longest edge running from the top-left towards the bottom-right. The lighting highlights the surface irregularities and the internal structure of the material.

The sample is a small, irregular, light-colored piece of material, possibly a mineral or rock, with a rough, crystalline texture. It is set against a dark, textured background. The sample is oriented diagonally, with its longest edge running from the top-left towards the bottom-right. The lighting highlights the surface irregularities and the internal structure of the material.





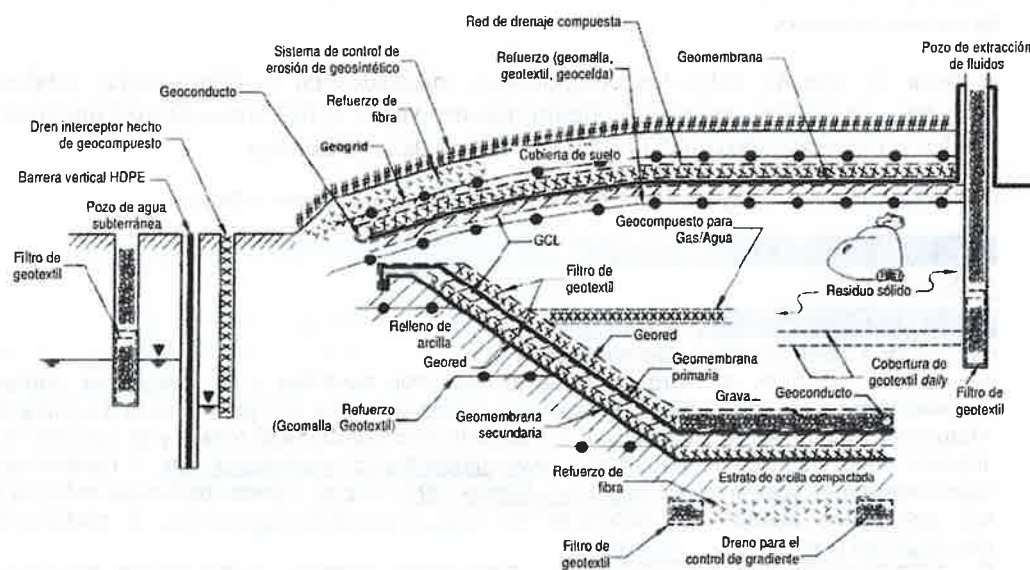
Geosintéticos en Rellenos Sanitarios

Preparado por M. Bouazza y J. Zornberg
Traducido por R. D. F. Durand ⁽¹⁾

Los geosintéticos son ampliamente utilizados en el diseño de sistemas de impermeabilización tanto de la base como la cobertura en instalaciones de rellenos sanitarios. Tales usos incluyen:

- geomallas, que pueden ser usados para reforzar taludes por debajo de los residuos así como para reforzar los suelos de cobertura por encima de las geomembranas;
- georedes, que pueden ser usadas en drenaje en planar;
- geomembranas, que son laminas poliméricas relativamente impermeables que pueden ser usadas como barreras de líquidos, gases y/o vapores;
- geocompuestos, que consisten en dos o mas geosintéticos, pueden ser usados para separación, filtración o drenaje;
- revestimiento de arcilla geosintética (GCL's), que son materiales compuestos de bentonita y geosintéticos que pueden ser usados como barrera hidráulica o de infiltración.
- Geotuberías, que pueden ser usadas en aplicaciones en rellenos sanitarios para facilitar la colección y el rápido drenaje de líquidos lixiviados en dirección de un receptor y luego hacia un sistema de eliminación.
- geotextiles, que pueden ser usados con fines de filtración o como un colchón para proteger geomembranas contra el punzonado.

La figura abajo ilustra los múltiples usos de geosintéticos como cobertura y como base en sistemas de revestimiento de una instalación moderna de relleno sanitario.



El sistema de revestimiento de base ilustrado en la figura arriba es un sistema de doble revestimiento compuesto. Este incluye un compuesto Geomembrana/GCL como sistema primario de revestimiento y un compuesto geomembrana/arcilla compactada como

sistema de revestimiento secundario. El sistema de detección de fugas, localizado entre los revestimientos primario y secundario, es un compuesto geotextil/geored. El sistema de colección de líquidos lixiviados sobre el revestimiento primario consiste de grava con una red de geotuberías perforadas. Una capa de protección de geotextil por debajo de la grava provee un colchón para proteger la geomembrana primaria del punzonado de piedras de encima. El sistema de colección de líquidos lixiviados sobre la cobertura primaria en los lados del talud del sistema de revestimiento es conformado por un geocompuesto de drenaje (compuesto geotextil/geored) incorporado dentro de la grava sobre la base. Un filtro geotextil cubre toda la base del relleno sanitario y previene la obstrucción de los sistemas de colección y remoción de lixiviados. El nivel freático puede ser controlado en el fondo del relleno mediante drenes de control de gradiente contruidos usando geotextiles. El suelo de fundación puede ser estabilizado usando refuerzos de fibra distribuidos en forma aleatoria, mientras que los taludes de suelo empinados debajo del revestimiento son reforzados usando geomallas.

El sistema de cobertura del relleno sanitario ilustrado en la figura contiene una barrera formada por una capa de compuesto geomembrana/GCL. La capa drenante sobre la geomembrana es de geocompuesto de drenaje (geotextil/geored). Adicionalmente, el sistema de cobertura de suelo incluye refuerzos de geomalla, geotextil, o geocelda por debajo del sistema de barrera de infiltración. Esta capa de refuerzos puede ser usado para minimizar las deformaciones en las capas impermeabilizantes debido a asentamientos diferenciales de los residuos o por una expansión vertical futura del relleno sanitario. Adicionalmente, el sistema de cobertura puede incluir un refuerzo de geomalla o geotextil sobre la barrera de infiltración para la estabilidad de la cubierta vegetal. Refuerzos de fibra también pueden ser usados en la estabilización de las zonas empinadas de suelo de cobertura vegetal. La figura muestra un geocompuesto de control de erosión encima del suelo de cubierta vegetal y provee protección contra la erosión. La figura también ilustra el uso de geotextiles como filtros en pozos de extracción de agua subterránea y de líquidos lixiviados. Finalmente, la figura muestra el uso de un sistema de barrera vertical de HDPE y un geocompuesto como dren interceptor a lo largo del perímetro de la instalación de relleno sanitario.

A pesar de que no todos los componentes mostrados en la figura serían totalmente necesarios en relleno sanitario, la figura muestra varias aplicaciones de geosintéticos que pueden ser considerados en el diseño de este tipo de instalaciones.

(*) Raúl Darío Durand F. es Ingeniero Civil, M.Sc. en Geotecnia por la Universidad de Brasilia.

Sobre la IGS

La Sociedad Internacional de Geosintéticos (International Geosynthetic Society – IGS) es una organización sin fines de lucro dedicada al desarrollo científico y tecnológico de geotextiles, geomembranas, productos afines y tecnologías relacionadas. La IGS promueve la diseminación de información técnica sobre geosintéticos a través de informativos (IGS News) y de sus dos revistas oficiales (Geosynthetic International - www.geosynthetic-international.com y Geotextiles and Geomembranes - www.elsevier.com/locate/geotextmem). Informaciones adicionales sobre la IGS y sus actividades pueden ser obtenidas en www.geosyntheticssociety.org o contactando la Secretaria de la IGS (IGSsec@aol.com).

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Geofantex GCL

Technical Data Sheet

Geofantex GCL May 2019

Geofantex GCL is a Geosynthetic Clay Liner and represents one of the most modern geosynthetic products available today. Geofantex GCL is a triple-layer composite containment (waterproofing) system comprising two geotextiles sandwiching a layer of highly reactive sodium bentonite material. When this sodium bentonite comes into contact with water, it swells to form an impermeable layer, typically with similar permeability characteristics as a one metre compacted clay layer.



Applications - - landfill construction, basement waterproofing, tailings dams in mining projects, building waterproofing, hydraulic engineering, artificial lakes / reservoirs, gas / vapor barriers, groundwater protection, coastal projects and general waterproofing applications.

Installation - Geofantex- GCL offers large savings over traditional construction methods, is easy to install, requires no specialised labour or welding equipment.

Differing engineering properties are achieved by using a variety of woven / nonwoven geotextiles within the manufacturing process.

Mechanical Properties

(T: Typical value M: Minimum Average Roll Value - MARV)

Standards	Unit	Technical Specification GCL-NP
Geotextile Properties		
Top/Cap Nonwoven geotextile [ASTM D 5261]	g/m ²	220
Woven geotextile [ASTM D 5261]	g/m ²	110
Bentonite Properties		
Weight [ASTM D 5993]	g/m ²	4670
Swell index [ASTM D 5890]	ml/2g	≥24
Moisture Content [ASTM D 4643]	%	12
Fluid Loss [ASTM D 5891]	ml	18
Finished GCL Properties		
Mass per unit area	g/m ²	≥5000
Blue absorption capacity	g/100g	≥30
Max. tensile strength, MD/CMD [ASTM D 4632]	N/100mm	≥600
Elongation at break, MD/CMD	%	≥10
Peel strength [ASTM D 6496] Nonwoven/woven	N/100mm	≥60
CBR Static Puncture [ASTM D 6241]	KN	2
Permeability/Hydraulic Conductivity [ASTM D5887]	m/s	≤5.0×10 ⁻¹²
Hydrostatic pressure-resistant		0.6MPa,1h No infiltration
Index Flux	(m ³ /m ²)/s	≤ 1 × 10 ⁻⁸
Bentonite wear	ml/2g	≥24
Soaked pressure- resistance [ASTM D 5321]		≥24KPa Typical

Above values are on an average basis, the data was obtained from In-house test laboratory, National test institutes and International test Institutes. Geofantex Geosynthetics keeps the right, of data changes and the final explanation right. Liability Exclusion: This publication should not be construed as engineering advice.

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1. Introduction



The purpose of this report is to investigate the effect of the mass of the falling weight on the time taken for the weight to fall a certain distance. The experiment was carried out using a simple pendulum and a stopwatch. The results were then plotted on a graph of time squared against mass, and a straight line was drawn through the points. This line was then used to predict the time taken for a weight of a certain mass to fall a certain distance.

The first part of the report describes the theory behind the experiment. This is followed by a description of the apparatus and the method used. The results are then presented in a table, and a graph is plotted. Finally, the results are discussed and conclusions are drawn.

The theory of the experiment is based on the fact that the time taken for a weight to fall a certain distance is proportional to the square root of the mass of the weight.

This can be expressed mathematically as follows:

$$t \propto \sqrt{m}$$

where t is the time taken for the weight to fall a certain distance, and m is the mass of the weight.

This equation can be rearranged to give:

$$t^2 \propto m$$

This shows that the time squared is proportional to the mass. This can be used to predict the time taken for a weight of a certain mass to fall a certain distance.

The experiment was carried out using a simple pendulum and a stopwatch. The results were then plotted on a graph of time squared against mass, and a straight line was drawn through the points.

This line was then used to predict the time taken for a weight of a certain mass to fall a certain distance.

The results of the experiment are shown in the table below.

The graph of time squared against mass is shown below.



The straight line shows that the time squared is proportional to the mass, as predicted by the theory.

The results of the experiment are in good agreement with the theory.



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The results of the experiment are in good agreement with the theory. The straight line shows that the time squared is proportional to the mass, as predicted by the theory. The results of the experiment are in good agreement with the theory.



UNIVERSITY OF THE WEST OF SCOTLAND

ESPECIFICACIONES DE LOS MATERIALES

GEOMEMBRANA



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ESPECIFICACIONES

DE LOS

MATERIALES

GEOMEMBRANA

ESPECIFICACIÓN PARTICULAR 01:

E.P. 01 GEOMEMBRANA DE POLIETILENO 1.0mm GRI

GENERALIDADES:

Las geomembranas deben ser fabricadas con resina de polietileno virgen mediante calandrado. Los rollos de geomembrana no deben tener uniones, ni contener plastificantes u otras cargas, y deben estar libres de agujeros, abrasiones o contaminantes. Las geomembranas se suministrarán como láminas continuas sin uniones de fábrica en los rollos.

Dentro de sus propiedades deberá ser:

- Estable a los rayos U.V.
- Resistente al hinchado y a la putrescibilidad
- Resistente a la perforación
- Resistente a las raíces
- Resistente a los asfaltos y aceites
- Soldable por aire caliente, por cuña caliente o por extrusión
- Resistente al agrietamiento por esfuerzos
- Resistencia a químicos

PROPIEDADES FÍSICAS

Propiedad	M. Ensayo	Unidad	Valor	Frecuencia
Densidad de la Materia Prima	ASTM D 792	g / cm ³	≥ 942	-
Índice de Fluidez	ASTM D 1238 (190°C / 2.16 Kg)	g / 10 min	<0.40	Por lote
Densidad de la Geomembrana	ASTM D 792	g / cm ³	0.946 ± 0.04	90.000 kg
Contenido en Negro de Carbono	ASTM D 4218	%	2.0 – 2.5	Cada rollo
Dispersión en Negro de Carbono	ASTM D 5596	Categoría	-	20.000 kg
Estabilidad Dimensional	ASTM D 1204 (100°C / 1 h)	%	± 1.5	Por día
Fragilidad a Bajas Temperaturas (-70 °C)	ASTM D 746	-	Sin grietas	Por formulación

PROPIEDADES DE DURABILIDAD

Propiedad	M. Ensayo	Unidad	Valor	Frecuencia
Resistencia Stress Cracking	ASTM D 5397 / ISO 18488	h	≥ 1,500	90,000 kg
Tiempo de Inducción A la Oxidación (OIT) Std OIT HP OIT	ASTM D 3895 ASTM D 5885	min	≥ 120 ≥ 500	90,000 kg
Envejecimiento a 85°C. HP OIT % retenido Después de 90 días	ASTM D 5721 ASTM D 5885	%	≥ 80	Por formulación
Resistencia UV. HP OIT % retenido Después de 1600 h	ASTM D 7238 ASTM D 5885	%	≥ 75	Por formulación
Oxidación	EN 14575	%	- 15	Por formulación

PROPIEDADES DE FABRICACIÓN

PROPIEDADES DE FABRICACION									
Propiedad	M. Ensayo	Ud.	Valor						Frecuencia
Espesor Nominal y Mínimo Medio.	ASTM D 5199	mm	0.75	1.00	1.50	2.00	2.50	3.00	Cada rollo
Espesor Mínimo Puntual		%	-10						

PROPIEDADES MECÁNICAS

PROPIEDADES MECÁNICAS									
Resistencia en Límite Elástico	ASTM D 6693 Type IV	N /mm	13 (12)	18 (16)	26 (24)	35 (32)	44 (40)	53 (48)	9,000 kg
Elongación en Límite Elástico		%	≥ 13						
Resistencia en Rotura		N / mm	24 (20)	32 (27)	48 (40)	64 (53)	80 (67)	96 (80)	
Elongación en Rotura		%	800 (700)						
Resistencia al Desgarro	ASTM D 1004	N	≥ 95	≥ 135	≥ 202	≥ 270	≥ 337	≥ 405	20,000 kg
Punzonado Elástico	ASTM D 4833	N	≥ 270	≥ 350	≥ 490	≥ 640	≥ 810	≥ 980	20,000 kg

Los rollos en el almacén deberán de conservarse en un lugar seco, protegidos del calor. Deberán estar en posición horizontal, paralelos entre sí (nunca cruzados) y dentro del empaque de origen. La manera de almacenarlos no deberá causar daños a la geomembrana.

La unión entre láminas podrá realizarse por soldadura con aire caliente, con cuña caliente o por extrusión.

Para proteger a la geomembrana contra rugosidades, o partículas agresivas del suelo, que puedan punzonarla, se colocará previamente a la geomembrana un geotextil para protegerla.

EJECUCIÓN:

Para la colocación de la geomembrana se realizará primeramente una zanja perimetral.

Entre cada rollo se deberán dejar traslapes de al menos 10 cm, que permitan soldar la membrana. Esta soldadura deberá de verificarse a su entrega.

MEDICIÓN:

Se medirá tomando como unidad el metro cuadrado de material colocado.

BASE DE PAGO:

El pago se hará por unidad de obra terminada, de acuerdo al precio fijado en el contrato, por metro cuadrado de geomembrana. Este precio incluye lo que corresponda a la adquisición de la geomembrana, cargas, descargas y transportes al lugar de la obra; tiempos muertos de los vehículos; cortes traslapes y desperdicios; las fijaciones necesarias para su soporte temporal; el equipo, las herramientas y mano de obra especializada; colocación; obras auxiliares y, en general, cualquier equipo, material y mano de obra que se requieran para la correcta ejecución de estos trabajos.





ESPECIFICACIÓN PARTICULAR 02:

E.P. 02 GEOTEXTIL DE SEPARACIÓN Y DE PROTECCIÓN A LA GEOMEMBRANA

GENERALIDADES:

Para evitar que la membrana de polietileno pueda punzonarse por partículas agresivas, se colocará previamente a la geomembrana un geotextil no tejido de 200 gr/m² para protegerla.

Este geotextil deberá ser no tejido, de poliéster.

- Resistencia a la Tensión Grab (ASTM D 4632) de 486 N / 49.60 Kg.
- Elongación Grab (ASTM D 4632) mayor al 70%.
- Resistencia al Desgarre Trapezoidal (ASTM D 4533) de 186 N / 19.0 Kg.
- Resistencia al Estallamiento Mullen (ASTM D 3786) de 1,336 KPa.
- Resistencia al punzonamiento (ASTM D 4833) de 241 N / 24.60 Kg.
- Además, deberá de ser resistente a los rayos U.V., a la putrescibilidad y a los químicos.

Los rollos en el almacén deberán de conservarse en un lugar seco, protegidos del calor. Deberán estar en posición horizontal, paralelos entre sí (nunca cruzados) y dentro del empaque de origen. La manera de almacenarlos no deberá causar daños a la geomembrana.

La unión entre rollos deberá realizarse con calor.

EJECUCIÓN:

Para la colocación del geotextil se realizará primeramente una zanja perimetral, Posteriormente se extenderán los rollos de geotextil para cubrir toda el área.

MEDICIÓN:

Se medirá tomando como unidad el metro cuadrado de material colocado.

BASE DE PAGO:

El pago se hará por unidad de obra terminada, de acuerdo al precio fijado en el contrato, por metro cuadrado de geotextil colocado. Este precio incluye lo que corresponda a adquisición de los geotextiles, cargas, descargas y transportes al lugar de la obra; tiempos muertos de los vehículos; cortes traslapes y desperdicios; las fijaciones necesarias para su soporte temporal; el equipo, las herramientas y mano de obra especializada; colocación; obras auxiliares y, en general, cualquier equipo, material y mano de obra que se requieran para la correcta ejecución de estos trabajos.



The following is a list of the names of the members of the American Medical Association who have been elected to the office of President for the year 1933.

Dr. J. C. Brannan, of the University of California, has been elected President of the American Medical Association for the year 1933. Dr. Brannan is a member of the American Medical Association since 1908 and has served in various capacities, including President of the California Medical Association and President of the American Medical Association for the year 1928.

Dr. Brannan is a graduate of the University of California and has been a member of the American Medical Association since 1908. He is currently a professor of medicine at the University of California and is also a member of the American Medical Association.

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ESPECIFICACIÓN PARTICULAR 01:

E.P. 01 GEOMEMBRANA DE POLIETILENO 1.5mm TEXTURIZADA AMBAS CARAS GRI

GENERALIDADES:

La geomembrana texturizada estructurada fabricada con resinas de la mayor calidad de Polietileno (HDPE) junto con un paquete de antioxidantes específico, mediante la más avanzada tecnología por calandrado (flat-die).

El tipo de texturización estructurada hacen que se mantengan unas excelentes propiedades mecánicas como la Elongación a la Rotura. La regularidad en la altura de aspereza y la densidad de picos producen una fricción entre las interfaces más alta que las técnicas tradicionales. También incluye una parte lisa en los bordes para asegurar la calidad de la soldadura.

Dentro de sus propiedades deberá ser:

- Estable a los rayos U.V.
- Resistente al hinchado y a la putrescibilidad
- Resistente a la perforación
- Resistente a las raíces
- Resistente a los asfaltos y aceites
- Soldable por aire caliente, por cuña caliente o por extrusión
- Resistente al agrietamiento por esfuerzos
- Resistencia a químicos

PROPIEDADES FÍSICAS

Propiedad	M. Ensayo	Unidad	Valor	Frecuencia
Densidad de la Materia Prima	ASTM D 792	g / cm ³	≥ 942	-
Índice de Fluidez	ASTM D 1238 (190°C / 2.16 Kg)	g / 10 min	<0.40	Por lote
Densidad de la Geomembrana	ASTM D 792	g / cm ³	0.946 ± 0.04	90.000 kg
Contenido en Negro de Carbono	ASTM D 4218	%	2.0 – 2.5	Cada rollo
Dispersión en Negro de Carbono	ASTM D 5596	Categoría	-	20.000 kg
Estabilidad Dimensional	ASTM D 1204 (100°C / 1 h)	%	± 1.5	Por día
Fragilidad a Bajas Temperaturas (-70 °C)	ASTM D 746	-	Sin grietas	Por formulación

PROPIEDADES DE DURABILIDAD

Propiedad	M. Ensayo	Unidad	Valor	Frecuencia
Resistencia Stress Cracking	ASTM D 5397 / ISO 18488	h	≥ 1,500	90,000 kg
Tiempo de Inducción A la Oxidación (OIT) Std OIT HP OIT	ASTM D 3895 ASTM D 5885	min	≥ 120 ≥ 500	90,000 kg
Envejecimiento a 85°C, HP OIT % retenido Después de 90 días	ASTM D 5721 ASTM D 5885	%	≥ 80	Por formulación
Resistencia UV, HP OIT % retenido Después de 1600 h	ASTM D 7238 ASTM D 5885	%	≥ 75	Por formulación
Oxidación	EN 14575	%	- 15	Por formulación

PROPIEDADES DE FABRICACIÓN

Propiedad	M. Ensayo	Ud.	Valor						Frecuencia
Espesor Nominal	ASTM D 5994	mm	----	1.00	1.50	2.00	2.50	3.00	Cada rollo
Tolerancia Espesor Medio		%	±5						
Tolerancia Espesor Puntual		%	±10						

PROPIEDADES MECÁNICAS

PROPIEDADES MECÁNICAS									
Resistencia en Límite Elástico	ASTM D 6693 Type IV	N /mm	----	18 (16)	26 (24)	35 (32)	44 (40)	53 (48)	9,000 kg
Elongación en Límite Elástico		%	≥ 10						
Resistencia en Rotura		N / mm	----	18 (15)	27 (22)	36 (30)	45 (37)	54 (47)	
Elongación en Rotura		%	500 (400)						
Resistencia al Desgarro	ASTM D 1004	N	----	≥ 135	≥ 202	≥ 270	≥ 337	≥ 405	20,000 kg
Punzonado Elástico	ASTM D 4833	N	----	≥ 320	≥ 450	≥ 570	≥ 690	≥ 820	20,000 kg

Propiedad	M. Ensayo	Ud.	Valor	Fr.
Altura de Estructurado	ASTM D 7466	mm	0.60 (0.45)	Cada 2 rollos
Ángulo de Fricción	ISO 12957-1	°	≥ 29	-
Densidad de Conos	-	Conos / m ²	83,700	-

Los rollos en el almacén deberán de conservarse en un lugar seco, protegidos del calor. Deberán estar en posición horizontal, paralelos entre sí (nunca cruzados) y dentro del empaque de origen. La manera de almacenarlos no deberá causar daños a la geomembrana.

La unión entre láminas podrá realizarse por soldadura con aire caliente, con cuña caliente o por extrusión.

Para proteger a la geomembrana contra rugosidades, o partículas agresivas del suelo, que puedan punzonarla, se colocará previamente a la geomembrana un geotextil para protegerla.

EJECUCIÓN:

Para la colocación de la geomembrana se realizará primeramente una zanja perimetral.

Entre cada rollo se deberán dejar traslapes de al menos 12 cm, que permitan soldar la membrana. Esta soldadura deberá de verificarse a su entrega.

MEDICIÓN:

Se medirá tomando como unidad el metro cuadrado de material colocado.

BASE DE PAGO:

El pago se hará por unidad de obra terminada, de acuerdo al precio fijado en el contrato, por metro cuadrado de geomembrana. Este precio incluye lo que corresponda a la adquisición de la geomembrana, cargas, descargas y transportes al lugar de la obra; tiempos muertos de los vehículos; cortes traslapes y desperdicios; las fijaciones necesarias para su soporte temporal; el equipo, las herramientas y mano de obra especializada; colocación; obras auxiliares y, en general, cualquier equipo, material y mano de obra que se requieran para la correcta ejecución de estos trabajos.

ESPECIFICACIONES DE LOS MATERIALES

GEOTEXTIL

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ESPECIFICACIONES

DE LOS

MATERIALES

GEOTEXTIL

Mirafi® RS380i



Mirafi® RS380i is a revolutionary geotextile with orange identification yarns and super high-tenacity polypropylene filaments formed into an innovative weave to provide superior reinforcement strength and soil interaction integrated with high water flow and soil retention capabilities.

TenCate Geosynthetics Americas Laboratories are accredited by [a2La](#) (The American Association for Laboratory Accreditation) and Geosynthetic Accreditation Institute – Laboratory Accreditation Program ([GAI-LAP](#)).

Mechanical Properties	Test Method	Unit	Typical Roll Value	Minimum Average Roll Value
Tensile Strength @ 2% strain (MD)	ASTM D4595	lbs/ft (kN/m)	720 (10.5)	600 (8.8)
Tensile Strength at 2% Strain (CD)	ASTM D4595	lbs/ft (kN/m)	1200 (17.5)	1020 (14.9)
Tensile Strength @ 5% strain (MD)	ASTM D4595	lbs/ft (kN/m)	2100 (30.6)	1800 (26.3)
Tensile Strength @ 5% strain (CD)	ASTM D4595	lbs/ft (kN/m)	2580 (37.6)	2256 (32.9)
Flow Rate	ASTM D4491	gal/min/ft ² (l/min/m ²)	85 (3463)	75 (3056) ¹
Permittivity	ASTM D4491	sec ⁻¹	1.2	0.9 ¹
			Typical Roll Value	
Pore Size 0 ₉₅	ASTM D6767	microns	365	
Pore Size 0 ₅₀	ASTM D6767	microns	185	
Index Properties			Maximum Opening Size	
Apparent Opening Size (AOS)	ASTM D4751	U.S. Sieve (mm)	50 (0.30)	40 (0.425)
			Minimum Test Value	
Interaction Coefficient ²	ASTM D6706	—	0.89	
Factory Sewn Seam	ASTM D4884	lbs/ft (kN/m)	2700 (39.4)	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	90	

¹ Minimum Roll Value

² Interaction Coefficient value is for sand or gravel based on testing conducted by SGI Testing Services.

Physical Properties	Unit	Roll Sizes	
Roll Dimensions (width x length)	ft (m)	15 x 300 (4.57 x 91)	17 x 300 (5.2 x 91)
Roll Area	yd ² (m ²)	500 (419)	567 (474)

U.S. Patent 8,333,220 and Pending

Interaction Coefficient (ASTM D6706) is not covered by our current A2LA accreditation.

TenCate, Mirafi, and the color ORANGE used in connection with geosynthetic or geotextile products are registered and/or unregistered trademarks of Nicolon Corporation.

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ESPECIFICACIONES DE LOS MATERIALES

TUBERIA

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ESPECIFICACIONES

DE LOS

MATERIALES

TUBERIA

Tubería PEAD para Conducción de 4", de RD 13.5 (PT 11kg/cm² PSI157)

La tubería de Polietileno de Alta Densidad PTM® utilizada a presión, está Certificada de conformidad con la Norma Oficial Mexicana: NOM 001 CONAGUA- 2011. "Sistema de Agua Potable, Toma domiciliaria y Alcantarillado Sanitario - Hermeticidad - Especificaciones y métodos de prueba. Es manufacturada según las especificaciones de la Norma Mexicana NMX-E-018-CNCP-2012, "Industria del Plástico - Tubos de Polietileno Alta Densidad (PEAD) para la conducción. Disponibilidad en diámetros de ½" a 24", presentación en tramos de 6 m y 12 m en diámetros de 2" a 24". También tenemos disponibles longitudes especiales dependiendo del diámetro y RD. PTM® ofrece conexiones de PEAD liso inyectadas y segmentadas tanto para termofusión como electrofusión.

Características y Ventajas: La tubería de PEAD de pared sólida e interior liso de PTM® se utiliza en los sistemas de conducción de agua potable, industria minera, conducción de aguas residuales, laboratorios e industrias, Es fabricada con equipos de última tecnología.

Materia Prima: La tubería de PEAD de pared sólida e interior liso, es fabricada con resina bimodal Certificada PE4710 o PE 100 según aplique. Presenta propiedades mecánicas superiores como dureza, resistencia a la tensión, impacto, aplastamiento y abrasión. Es de alta resistencia química, no tóxica y larga vida útil.

Mayor Hermeticidad: La tubería de PEAD de pared sólida e interior liso puede ser unida por termofusión a tope, método con el cual se consigue una unión monolítica más resistente que la tubería misma 100% hermética.

Fácil de Instalar: La tubería PEAD de pared sólida e interior liso es ligera en peso y flexible, adaptándose a terrenos irregulares y soportando cargas dinámicas, lo que conlleva a su facilidad de instalación de bajo costo.

Control de Calidad: La tubería de PEAD de pared sólida e interior liso de PTM® es probada de conformidad con las Normas correspondientes en laboratorio acreditado por la EMA (Entidad Mexicana de Acreditación).

Aplicaciones:

Algunas de las aplicaciones en donde se recomienda utilizar esta tubería hidráulica de PVC son:

Instalaciones en Albercas,

Balnearios,

Tinas de Hidromasaje, etc.

Sistemas de Riego en campos de GOLF

Tratamiento de Agua Residuales y Conducción de Lixiviados

Instalaciones Electromecánicas
Instalaciones Hidrosanitarias
Bajadas Pluviales
Agua Helada y Torres de Enfriamiento
Líneas de distribución de Agua de Proceso
Inyección de Cloro y Dióxido Clorhídrico
Sistemas de Manejo de Alumbre y Cáusticos

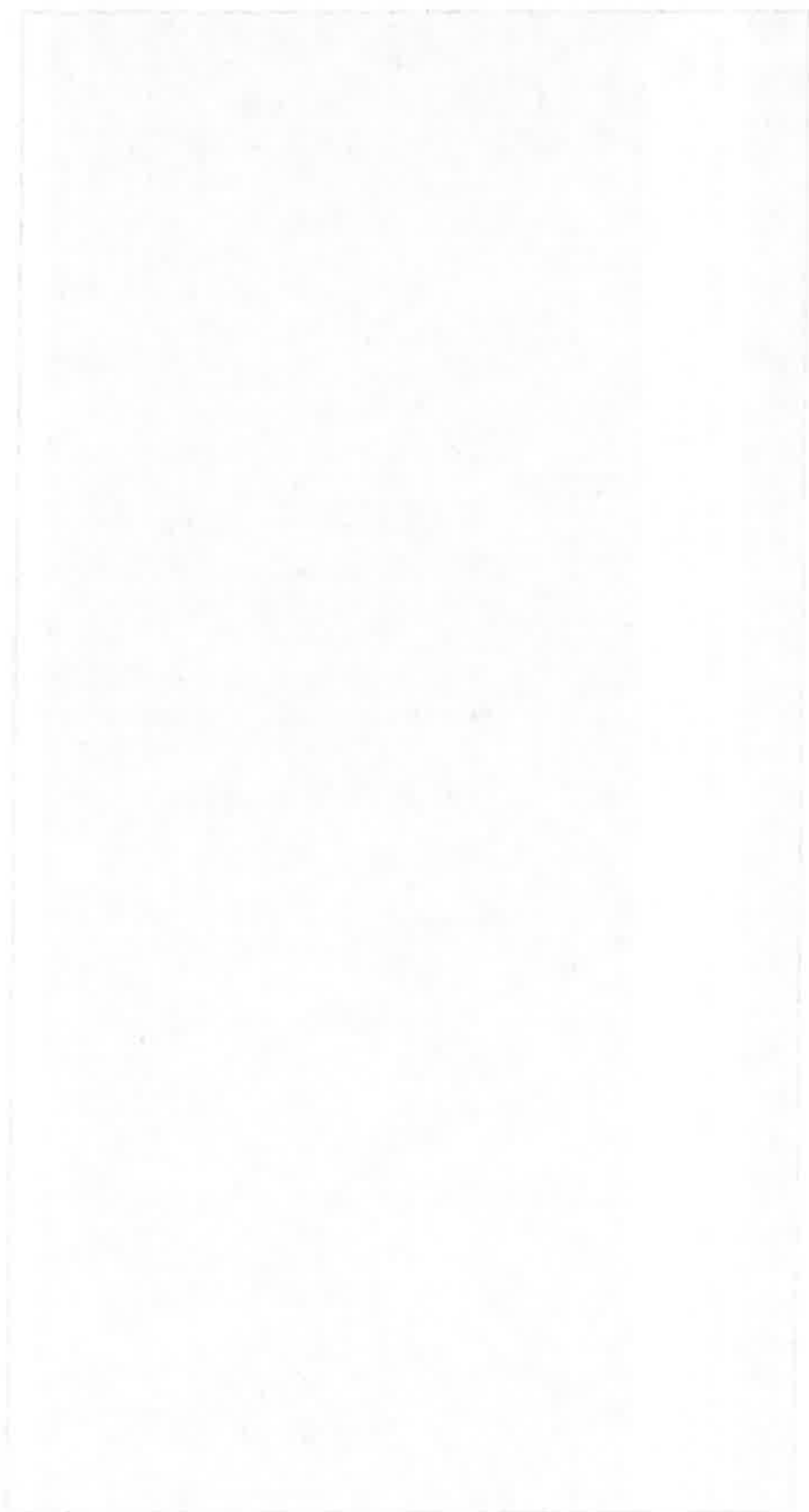
Dimensiones:

ESPESOR DE PARED (e)												
DIÁMETRO NOMINAL (DN)	DIÁMETRO EXTERIOR (De)	RD 7 PT 23kg/cm ² PSI 327	RD 7.3 PT 22kg/cm ² PSI 313	RD 9 PT 17kg/cm ² PSI 242	RD 11 PT 14kg/cm ² PSI 199	RD 13.5 PT 11kg/cm ² PSI 157	RD 15.5 PT 10kg/cm ² PSI 142	RD 17 PT 9kg/cm ² PSI 128	RD 21 PT 7kg/cm ² PSI 100	RD 26 PT 6kg/cm ² PSI 85	RD 32.5 PT 4kg/cm ² PSI 57	RD 41 PT 3kg/cm ² PSI 43
1/2"	21.3	3.0	2.9	2.4	1.9	1.6						
3/4"	26.7	3.8	3.7	3.0	2.4	2.0						
1"	33.4	4.8	4.6	3.7	3.1	2.5						
1 1/4"	42.2	6.0	5.8	4.7	3.8	3.1	2.7	2.5				
1 1/2"	48.3	6.9	6.6	5.4	4.4	3.6	3.1	2.8				
2"	60.3	8.6	8.3	6.7	5.5	4.5	3.9	3.6	2.9	2.3		
2 1/2"	73.0	10.4	10.0	8.1	6.6	5.4	4.7	4.3	3.5	2.8	2.3	
3"	88.9	12.7	12.2	9.9	8.1	6.6	5.7	5.2	4.2	3.4	2.7	
4"	114.3	16.3	15.7	12.7	10.4	8.5	7.4	6.7	5.4	4.4	3.5	2.8
6"	168.3	24.0	23.1	18.7	15.3	12.5	10.8	9.9	8.0	6.5	5.2	4.1
8"	219.1	31.3	30.0	24.3	19.9	16.2	14.1	12.9	10.4	8.4	6.7	5.3
10"	273.1	39.0	37.4	30.3	24.8	20.2	17.6	16.1	13.0	10.5	8.4	6.7
12"	323.8	46.3	44.4	36.0	29.4	24.0	20.9	19.1	15.4	12.5	10.0	7.9
14"	355.6	50.8	48.7	39.5	32.3	26.3	22.9	20.9	16.9	13.7	10.9	8.7
16"	406.4	58.1	55.8	45.2	37.0	30.1	26.2	23.9	19.4	15.6	12.5	9.9
18"	457.2	65.3	62.6	50.8	41.6	33.9	29.5	26.9	21.8	17.6	14.1	11.2
20"	508.0	72.6	69.7	56.4	46.2	37.6	32.8	29.9	24.2	19.5	15.6	12.4
22"	558.8	79.8	76.6	62.1	50.8	41.4	36.0	32.9	26.6	21.5	17.2	13.6
24"	609.6	87.1	83.5	67.7	55.4	45.2	39.3	35.9	29.0	23.4	18.7	14.9

PT Presión de trabajo

PT Presión de trabajo

Nota : El RD 13.5 equivale a 8.5 mm.



Tubería Hidráulica de PVC de 4" Cedula 40 Cementar/ASTM

El PVC o Policloruro de Vinilo (del inglés polyvinyl chloride) es un polímero termoplástico de origen petroquímico. Fue utilizado por primera vez para la fabricación de tuberías en Alemania en la década de 1930 y fue introducido a México a principios de la década de 1960. Se presenta como un material blanco que comienza a reblandecer alrededor de los 80 °C y se descompone sobre 140 °C. Cabe mencionar que es un polímero por adición y además una resina que resulta de la polimerización del cloruro de vinilo o cloroetileno. Tiene una muy buena resistencia eléctrica y a la llama.

Desde sus inicios en la aplicación de tuberías ha dado magníficos resultados en instalaciones hidráulicas de diferentes tipos desde casas habitación hasta extensas redes de distribución de agua potable, redes de agua residual alcantarillado en grandes ciudades, laboratorios e industrias.

Existen varios tipos de uniones entre secciones de tubería de PVC entre los cuales podemos mencionar cementar y combinación de "Campana y Anillo". Ambos tipos de unión proporcionan una superficie interior lisa que permite el libre flujo de líquidos y desechos lo que los hace ideales para la conducción de aguas negras (lixiviados) y redes pluviales. Las uniones son herméticas, de fácil y rápida ejecución y no se requiere de experiencia o educación especial para su aplicación.

La tubería de PVC es un sustituto indiscutible de las tuberías metálicas por su resistencia al ataque de productos químicos y corrosivos, por su bajo costo, por la facilidad de instalación y por su durabilidad.

La tubería hidráulica de PVC cementar cumple con las normas mexicanas de calidad NMX-E-145 y las normas americanas ASTM D-2241 y ASTM D-1785 y cuentan con la certificación NSF y ASTM.

Características: La Tubería Hidráulica de PVC Cedula 40 cementar (Schedule 40 Pipe) se fabrica en Sistema Ingles dimensiones IPS (Iron Pipe Size), se fabrica bajo la norma americana ASTM D-1785 y la norma nacional NMX-E-145/1, se fabrica con resina (materia prima) virgen 12454-b de acuerdo a la norma americana ASTM D-1784, la longitud de esta Tubería Hidráulica de PVC son de 6.0 metros, en tubería nacional y 20 pies (6.10) metros, en tubería de importación, la temperatura máxima que se recomienda es de 140°F (60 °C), cuenta con un abocinado (Campana) en un extremo de la tubería el otro extremo es espiga, su fabricación es de Color Blanco y esta listada por el NSF-PW Standard 61 & Standard 14, se puede conectar con cualquier conexión de sistema Ingles la más recomendada seria Cedula 40, incluso la conexión de Cedula 80 es compatible para esta tubería. Sistema de unión con campana y anillo conforme a la norma ASTM F477 y ASTM D3139.

La temperatura de operación no debe de exceder los 60°C y en temperaturas de más de 23°C se tiene que aplicar un factor de corrección para la presión de Trabajo Factor de Corrección.

Ventajas: Durabilidad para aplicaciones en donde se requiere de resistencia química las tuberías de PVC son la mejor opción es por eso que el tiempo de vida útil es el de mayor durabilidad, Abocinado representa un ahorro de un coplee o una termofusión, ya que le permite ir uniendo las tuberías en un tendido lineal sin necesidad de coples adicionales, Economía el uso de PVC representa un ahorro significativo en el costo final de la instalación, Resistencia Química las Tubería hidráulica de PVC no permiten la corrosión e incrustación de los elementos que conducen, Bajo Peso el PVC es ligero y facilita las maniobras de almacenaje, transporte e instalación.

Aplicaciones:

Algunas de las aplicaciones en donde se recomienda utilizar esta tubería hidráulica de PVC son:

Instalaciones en Albercas,

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Inyección de Cloro y Dióxido Clorhídrico

Sistemas de Manejo de Alumbre y Cáusticos

Dimensiones:

DIAMETRO NOMINAL (PULG.)	DIAMETRO EXTERIOR (PULG.)(OD) (MM)	DIAMETRO INTERIOR (PULG.)(ID) (MM)	ESPESOR DE PARED (PULG.)(T) (MM)	PRESTÓN A 23°C (PSE) (KG/CM2)	PESO APROX KG/M
1/2"	0.840	0.609	0.109	600	0.24
3/4"	1.050	0.810	0.113	480	0.32
1"	1.135	1.033	0.133	450	0.47
1 1/4"	1.680	1.363	0.140	370	0.63
1 1/2"	1.900	1.593	0.145	330	0.76
2"	2.375	2.049	0.154	280	1.01
2 1/2"	2.875	2.455	0.023	300	1.60
3"	3.500	3.042	0.216	260	2.10
4"	4.500	3.989	0.237	220	2.98
6"	6.625	6.031	0.280	180	5.26
8"	8.625	7.942	0.322	160	7.89
10"	10.750	9.976	0.365	140	11.20
12"	12.750	11.889	0.406	130	14.80
14"	14.000	13.073	0.437	130	17.56
16"	16.000	14.940	0.500	130	22.93
18"	18.000	16.809	0.552	130	29.91
20"	20.000	18.743	0.593	120	35.13
24"	24.000	25.544	0.587	120	48.89

Nota: Cédula 40, equivale a 6.02 mm.

