



Geomembrane Installation Reference Manual

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1. General Description

1.1 Scope

This reference manual is the general description for the installation of Huitex geomembrane. All the operations, procedures and methods shall follow the specifications of the designer.

1.2 Submittal

1.2.1 Manufacturer

The manufacturer shall certificate the quality of geomembrane products meet the require specification.

1.2.2 The installer shall provide the following information prior to installation:

- A. Proposed installation/panel layout.
- B. Installation quality assurance plan.

1.3 Geomembrane Labeling

Each roll of geomembrane delivered to the site shall be labeled. The label shall identify:

- A. Manufacturer.
- B. Product model.
- C. Size (Length ×Width×Thickness)
- D. Roll number
- E. Net weight

2. Transportation, Loading, Unloading and On-site Storage of Geomembrane:

2.1 The delivery of geomembrane is carried out by shipping or trucking approved by the project owner. Appropriate protection is necessary to prevent the geomembrane from damaging.

2.2 Strong, woven slings or other applicable devices are used for geomembrane loading.



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- 2.3 Prior to unloading, the handling equipment is inspected to verify that it will not damage the material.
- 2.4 Rolls must be examined upon unloading to insure that there is no damage to the material and to assure that the correct material for the job has been received.
- 2.5 Rolls piling should not exceed (max.) 4 rolls high for HDPE/LLDPE SMOOTH material and (max.) 3 rolls high for HDPE/LLDPE TEXTURED material. Heavy duty wedges should be added to secure the bottom of the rolls and prevent the stack from collapsing.
- 2.6 Geomembrane shall be stored on the smooth ground without excessively hot or moist condition. Sharp objects or anything which may puncture the geomembrane shall be removed.
- 2.7 Under standard weather condition, the storage of geomembrane does not require special treatment.

3. Installation of Geomembrane:

3.1 Earthwork:

- 3.1.1 The work site shall be well prepared before the geomembrane installation. The subgrade shall be compacted in accordance with the project specifications.
- 3.1.2 Weak or compressible areas which can't be satisfactorily compacted should be removed and replaced with properly compacted fill. All surfaces to be lined shall be smooth, free of all foreign and organic material, sharp objects, or debris of any kind. The subgrade shall provide a firm, unyielding foundation with no sharp changes or abrupt breaks in grade. Water or excessive moisture is not allowed.
- 3.1.3 Before installation, the installer or inspector shall review and examine the work site to conform the required project specification.



3.2 Anchor Trench:

- 3.2.1 The anchor trench shall be excavated to the line, grade, and width shown on the project construction designs and drawings, prior to installation. Timing of procedure excavation shall be taken into consideration to prevent collapse. Slightly rounded corners are needed in the trench to avoid sharp bends in the geomembrane.
- 3.2.2 Refilling shall be careful to avoid damaging geomembrane.

3.3 Deployment of Geomembrane:

- 3.3.1 All machines or equipment used in the deployment shall be in appropriate manner to prevent geomembrane from possible damage, extension or wrinkles.
- 3.3.2 Sandbags or similarity placed on the geomembrane will not damage geomembrane and prevent wind uplift.
- 3.3.3 Smoking or shoes which may damage the geomembrane are not permitted on the geomembrane.
- 3.3.4 Unnecessary operation or movement on the geomembrane surface shall be avoided. Additional protective cover over the geomembrane is recommended.
- 3.3.5 Geomembrane placement shall fit the ground surface. Wrinkles should be avoided.
- 3.3.6 Geomembrane placement shall start from the top of work site and follow the wind direction.
- 3.3.7 Assign each deployed geomembrane panel a code for identification.
- 3.3.8 Sufficient material shall be supplied to allow the thermal expansion and contraction of geomembrane.
- 3.3.9 Welding should be performed as soon as possible after the geomembrane is placed.



3.4 Field Seaming

- 3.4.1 Moisture or dirt shall be removed from the geomembrane surface. Do not use any solvent or adhesive for cleaning or other purpose. At least 100mm (4 inches) range is required for the overlap to be seamed.
- 3.4.2 The seaming overlap shall be smooth and free of wrinkle or leak. Wrinkles and leaks shall be cut and replaced area shall be overlapped with a minimum range of 75mm (3”).
- 3.4.3 On-site slope seams shall parallel the direction of the slope, not across the slope. Unnecessary welding around the corner or uneven ground shall be avoided.

3.5 Weather Condition

- 3.5.1 Geomembrane placement shall be performed in appropriate whether temperatures of 0~40°C (32~104°F).
- 3.5.2 When the temperature is below 0°C, placement shall not be performed unless it has been verified that the seaming quality meets the specification requirement.
- 3.5.3 Geomembrane placement shall be stopped during any condition of excessive moisture, e.g. fog, rain, dew, snow, or in the condition of extreme winds.
- 3.5.4 If geomembrane placement is performed in low temperature or bad weather condition, installers shall notice and record the liner's surface temperature, ambient temperature, welding machine temperature setting, and actual welding machine temperature, and welding speed.
- 3.5.5 Before geomembrane placement, the installer shall evaluate temperature, moisture, rainfall, and wind velocity.

3.6 Preparation of Seaming



- 3.6.1 To approve seaming machines, condition, method, and quality can completely meet requirement during installation, seaming test shall be done in the same working environment and installation condition as in the actual site.
- 3.6.2 Frequency of seaming tests shall be agreed by both parties of the owner and installer.
- 3.6.3 Seam samples for shear strength test and peel strength tests shall be taken at the actual site.

3.7 Equipment and Accessories

- 3.7.1 Hot wedge welder and extrusion welder shall have the gauge for the temperature measurement and controlling The equipment shall be maintained in an adequate condition to avoid the delaying work.
- 3.7.2 Power supply electrical generator shall provide the constant voltage.

3.8 Trial Welds and Testing

- 3.8.1 Trial welds shall be performed on geomembrane samples to verify that the seaming machine and operating conditions are adequate.
- 3.8.2 The trial welds shall be the same geomembrane and environmental conditions as the actual welds, and the trial welds also shall be made in contact with the subgrade.
- 3.8.3 At least two trial welds shall be conducted per day for each welding machine. One is made at the beginning of work; the other is completed at the mid. shift.
- 3.8.4 The seaming test specimens(one inch width by six inches length) : 5 specimens are prepared for shear strength and 5 specimens for peel strength test.



3.8.5 If the testing values can't pass the required specifications, seaming shall be stopped until the problems are solved and the testing values achieve the acceptable trial welds.

4 Geomembrane Seaming:

4.1 Fusion (Hot Wedge) welding system

Fusion (Hot Wedge) welding is the primary welding method. Hot metal wedge is heated to the required temperature and used to melt the overlapped facing surfaces then they are pressed together with two nip/drive rollers to create a permanent bonding structure.

4.1.1 Geomembrane Preparation

- A. The overlap shall range from 100mm to 150mm (4"~6").
- B. Check the geomembrane to ensure there is no defect before joining.
- C. Overlapped range for seaming shall be smooth and free of wrinkle.
- D. Temperature impact shall be taken into account in advance.
- E. Any moisture or dirt on geomembrane shall be cleaned.
- F. The ground under geomembrane shall be dry to avoid the moisture affecting the seaming quality.
- G. The ideal weather temperature ranges from 0~40°C (32~104°F). If the welding is performed under low temperature, preheating is recommended.

4.1.2 Equipment Preparation

- A. Prepare a power generator and sufficient cord if necessary. Generator shall be allocated in a flat and stable place. Storage of fuel shall be far from the geomembrane.
- B. Welding wedge and platform shall be stable and no sharp object reaches the



geomembrane.

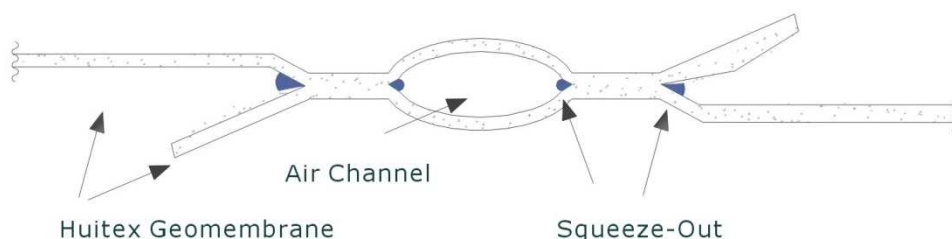
- C. Make sure the motor functions properly.

4.1.3 Fusion (Hot Wedge) Process:

- A. Seaming temperature setting is recommended at 325~400°C, upon the geomembrane thickness. Trial seaming can provide a seaming speed reference. Weather condition (e.g. temperature, sunshine, and wind) shall be taken into consideration as well.
- B. Turn off the motor before placing the overlap in the wedge and roller. After the overlap to be seamed is properly positioned, turn on the motor and lock the seam in position.
- C. The seaming machine shall be aligned and set to the adequate temperature, the travel speed of seaming machine is set depending on the geomembrane thickness and weather condition.
- D. The seaming operator shall take care of seaming machine for temperature and speed control to maintain a consistent weld.
- E. A small amount of squeeze-out is a good indication that the proper seaming temperature has been set. The melted material will lately be extruded out of the seam area. If there appears an excessive amount of hot extrude, it indicates that the temperature or pressure is too high and the adjustment is needed.
- F. For the thickness of 1 mm or less than 1 mm geomembrane products, if there shows a long, low, sinusoidal wavelength pattern in the direction of the seam, this indicates it is the proper seaming. If the wave peaks are too close, the seaming speed needs to be increased until an acceptable pattern appears. The absence of the waving length indicates that the seaming speed needs to be decreased. There will be no waving pattern for the thickness greater than 1mm because of the inherent stiffness.

- G. Nip/Drive roller marks will always show on the welding track surface, they are noticeable and slightly embossed.
- H. Daily checking and cleaning of welder are required.

DOUBLE HOT WEDGE WELDING SEAM PROFILE



4.2 Extrusion Welding System

Extrusion welding is primarily used for repairs, details (e.g. piping or trench) and T welding. The welding rods, with 4mm or 5mm diameter, which are made of the same material as the geomembrane, are extruded by the extrusion welder and pasted along the overlapped seam. Preheating of the geomembrane in the welding area is performed by the extrusion welder.

4.2.1 Geomembrane Preparation:

The overlap of two geomembranes shall range at least 150mm (6"). (See details in 4.1.1.).

4.2.2 Equipment Preparation:

- A. Prepare a power generator and sufficient cord if necessary. Generator shall be allocated in a flat and stable place. Storage of fuel shall be far from the geomembrane.
- B. Prepare a handheld grinder in 120mm diameter, #80-grit paper.



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- C. Prepare a hot air welder that can provide 600°C to tack the geomembrane.
- D. Verify each part of extrusion welder to ensure its properly functions and to control the temperature accurately.
- E. The extrusion welder should use Teflon die with changeable shapes and sizes. The Teflon die shall be replaced if the die is impaired, broken, indent or defective.

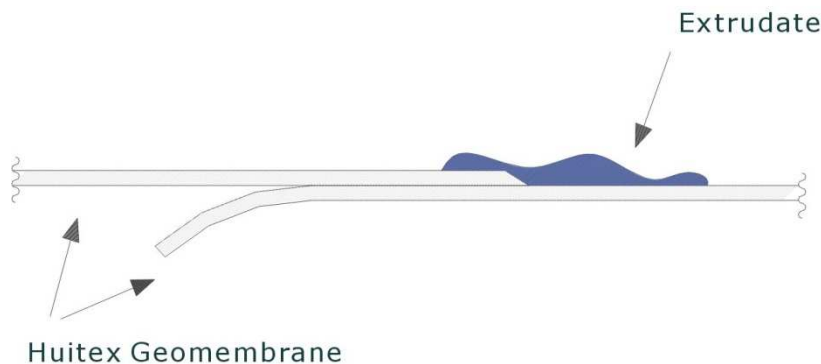
4.2.3 Extrusion Welding Process

- A. The seaming area shall be dry and clean.
- B. If the geomembrane thickness is greater than 1.5mm (60 mil), the leading edges of upper geomembrane layer shall be ground into 45° bevel. Beveling should be careful to prevent from damaging the lower layer, beveling should be done before tack welding.
- C. The geomembrane surface shall be slightly ground to remove the oxidized layer or other foreign materials. Grind depth shall not exceed 10% of the geomembrane thickness. Grind width shall match extruder; and not exceed either side of the extrudate.
- D. Seaming shall take place after grinding immediately, no more than 30 minutes.
- E. Hot air welder or other equipment can be used to tack two geomembranes binding together, but the over heat will damage the upper geomembrane.
- F. The Teflon die of the welder shall be checked for the correct dimension, the welder needs to be maintained at correct angle, stable speed, and alignment.
- G. The extrusion welder shall purge all degraded material in the barrel for

approximately 30 seconds before welding. The purge material shall not be discharged on the surface of the geomembrane.

- H. The overlap thickness shall be approximately twice of the geomembrane thickness, measured from the upper surface of the bottom geomembrane to the top of the extrudate.
- I. A small amount of squeeze-out appears on two sides of seaming track is allowed. If the amount of squeeze-out is too much, lower the extrusion welder temperature setting or increase the welding speed.
- J. If interruption is necessary during the welding process, trial-off the extrusion gradually instead of stopping instantly. To re-launch the welding process, grind the continued area before welding. To perform repairs, piping, other accessories, T welding and Y welding, follow the above procedures.

Extrusion Welding Seam



5 Seam Testing

5.1 Non-Destructive seam testing

The non-destructively test shall be performed during the installation and verified along



the seamed track over the full length to conform the continuity.

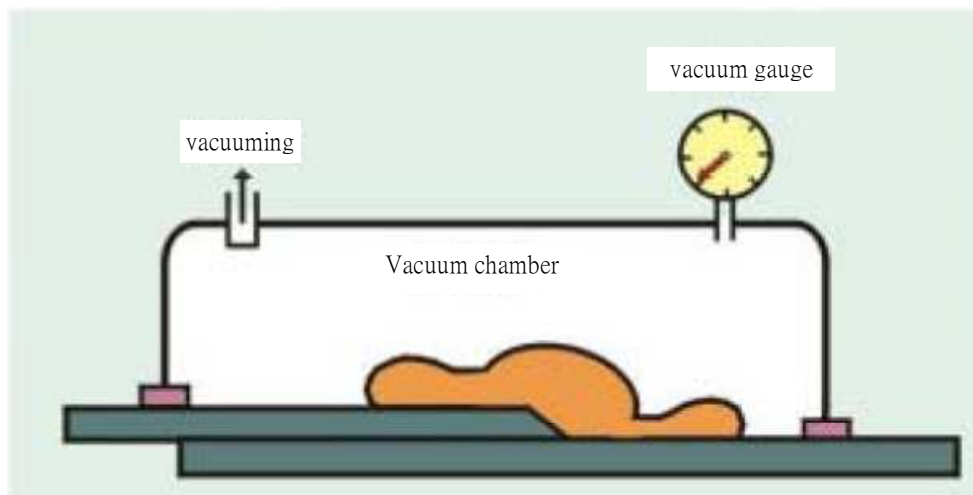
5.1.1 Vacuum Box Testing

A. Testing instrument shall contain the following:

- a. A vacuum box, consisting of a firm case with a transparent viewing window, a soft rubber gasket attached to the bottom, port hold or valve assembly, vacuum gauge, and tubes to connect the vacuum pump.
- b. A vacuum pumping device.
- c. A soapy solution and sprayer.

B. Testing Procedure

- a. Wet the tested area with soapy solution.
- b. Place the vacuum box over the wet area.
- c. Compress the vacuum box to seal the box.
- d. Actuate the vacuum valve, ensure that a leak tight is created.
- e. Hold a vacuum of a 28-55kPa (4-8 psi) for a duration of not less than 10 seconds. Observe the seam through the viewing window for presence of bubbles resulting from the defects seam.
- f. If no bubbles are observed, move box to the next section for testing and repeat the process. Two testing sections shall be with a minimum 50mm (2") overlap until the entire seam has been tested.
- g. If bubbles are observed, mark the section of the leak for repairing and retesting.



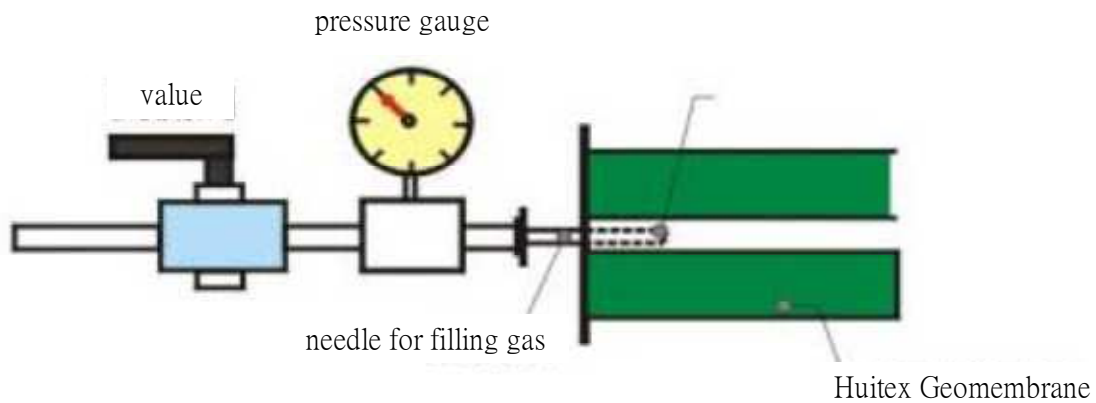
5.1.2 Air Pressure Testing (only for the double fusion welding)

A. Equipment for testing shall contain the following:

- a. Air Pump, equipped with pressure gauge capable of generating a pressure up to 350 kPa is necessary. It must be placed on an adequate cushion to prevent the geomembrane from being damaged. A flexible hose is used to connect the pump to the air pressure device.
- b. A sharp hollow needle with a pressure gauge attached.
- c. Pressure gauge, capable of indicating the air pressure in 7 kPa within the test range.

B. Testing Procedures:

- a. Seal both ends of the seam welded by the double wedge fusion welding.
- b. Insert the needle with the gauge into the air channel created by the double wedge fusion weld.
- c. Energize the air pump to pressure 25~30 psi., close the valve and maintain the pressure at least 5 minutes.
- d. If pressure has dropped more than 4 psi or pressure appears unstable, mark the section for repairing.
- e. If pressure maintains equilibrium and stable, open one end, and the air channel shall deflate immediately, indicating that the full length of the seam has been completely tested.



5.2 Destructive seam testing

- 5.2.1 The test results shall be concluded prior to the completion of installation. Samples should be obtained in the field. Sampling method and frequency shall comply with installation manual or be agreed by both parties of the project owners (contractors) and installers.
- 5.2.2 Sample size should be 300mm (12") x 910mm (36") with the seam centered lengthwise. All cut holes for obtaining the seam samples shall be immediately repaired and vacuum tested.
- 5.2.3 Seam samples can be sent to an independent laboratory for testing upon installation agreement or regulation. Shear strength testing and peel strength testing are required.
- 5.2.4 Seam samples shall be prepared as ten specimens of 25mm (1") x 150mm (6"): five for shear strength testing and five for peel strength testing.
- 5.2.5 Specification of seaming strength



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A. Minimum Weld Properties for Huitex HDPE Geomembrane

Property	Test Method	0.75 mm	1.0 mm	1.5 mm	2.0 mm	2.5 mm	3.0 mm
Hot Wedge Seams & Extrusion Fillet Seams Shear Strength, kN/m	ASTM D6392	11	14	21	29	36	42
Hot Wedge Seams Peel Strength, kN/m	ASTM D6392	8.6	12	17	23	28	35
Extrusion Fillet Seams Peel Strength, kN/m	ASTM D6392	6.8	9	14	18	23	28

B. Minimum Weld Properties for Huitex LLDPE Geomembrane

Property	Test Method	0.5 mm	0.75 mm	1.0 mm	1.5 mm	2.0 mm	2.5 mm
Hot Wedge Seams & Extrusion Fillet Seams Shear Strength, kN/m	ASTM D6392	5.9	7.8	10	15	21	26
Hot Wedge Seams Peel Strength, kN/m	ASTM D6392	4.5	6.5	8.7	13	17	22
Extrusion Fillet Seams Peel Strength, kN/m	ASTM D6392	3.9	6.0	7.8	12	16	20

6 Reference Standards for This reference manual,

6.1 ASTM D4437 ASTM Standards on Geosynthetics.

6.2 ASTM D5641 Standard Practice For Geomembrane Seam Evaluation By Vacuum Chamber.

6.3 ASTM D5820 Standard Practice For Pressurized Air Channel Evaluation Of Dual Seamed Geomembranes.

6.4 ASTM D6392 Standard Test Methods for Determining The Integrity of NonReinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.



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6.5 ASTM D6497 Standard Guide for Mechanical Attachment of Geomembrane to Penetration or Structures

6.6 GRI GM14 Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes.