6.8 Quality of bentonite per unit area of impervious liner

6.8.1 Apparatus

6.8.1.1 Industrial balance: the sensitivity is not more than 1 g.

6.8.1.2 Electric drying oven: the temperature range is 0 ℃~300 ℃, and the sensitivity of the thermostat is ±2 ℃.

6.8.1.3 Steel ruler: maximum range 1000 mm, division value 1 mm.

6.8.1.4 Scissors.

6.8.2 Testing procedure

Spray a small amount of water around the sampled impervious liner to prevent bentonite from being scattered at the cut place of the impervious pad. Cut the sample at the distance from the outer end 200 mm along the length direction and from the edge 10 mm along the width direction, and the sample size is 400 mm×400 mm with a measuring tool with an accuracy of 1 mm. Remove all the bentonite in the sample manually or mechanically, and impurities such as thread head and rags are not allowed in the raw material test sample. Dry the bentonite to constant weight at 105 ℃ ±2 ℃, and then weigh accurately to 1 g on the balance. Calculate the mass per unit area according to formula (3).

$$M = \frac{m}{s} \quad \cdots\cdots (3)$$

where

M is the mass per unit area, g/m^2;

m is the mass of the sample after drying to constant weight, g;

s is the initial area of sample, m^2.

6.9 Tensile strength of impervious liner

Tensile strength of impervious liner shall be tested in accordance with the GB/T 15788.

6.10 Elongation of impervious liner under maximum load

Elongation of impervious liner under maximum load shall be tested in accordance with

the GB/T 15788.

6.11 Peeling strength of impervious liner

Peeling strength of impervious liner shall be tested in accordance with the GB/T 2791. In the range of peel strength, the arithmetic average of the average peel strength of all samples is taken as the result.

6.12 Permeability coefficient of impervious liner

Permeability coefficient of impervious liner shall be performed in accordance with annex A.

6.13 Resistant to hydrostatic pressure of impervious liner

Resistant to hydrostatic pressure of impervious liner shall be tested in accordance with annex B.

6.14 Puncture strength of impervious liner

Puncture strength of impervious liner shall be performed in accordance with annex C.

6.15 Mass of geosynthetics per unit area

Mass of geosynthetics per unit area shall be performed in accordance with the GB/T 13762.

6.16 Room temperature flexibility

Room temperature flexibility shall be tested in accordance with the GB/T 328.14.

7 Inspection rule

7.1 Inspection classification

7.1.1 Factory inspection

The products should be inspected before leaving the factory. The inspection is qualified and the quality inspection certificate should be attached before leaving the factory.

Factory inspection items: visual quality, expansion index, filtration loss, change rate of expansion index, durability, mass of bentonite per unit area, tensile

strength, elongation under maximum load, permeability coefficient, hydrostatic pressure resistance.

7.1.2 Routine inspection

Routine inspection items include all requirements of Chapter 5. Routine inspection shall be performed in case any of the following situations occurs:

a) The routine production or routine inspection of a new product;

b) Inspection shall be done once every year for routine production;

c) Significant changes such as raw materials or production processes may affect the properties of a products;

d) The results of factory inspection are significantly different from the results of the last routine inspection;

e) Production resumes after suspension for over 6 months.

7.2 Batch principle

To the same type or the same model and specification of impervious liner 12000 m^2 as a batch, insufficient 12000 m^2 is also counted as a batch.

7.3 Sampling method

Five rolls are randomly selected for each batch of impervious liner products.

7.4 Sample preparation method

Test samples from each roll shall be prepared according to the sample size and quantity required as listed in Table 3. The sample is cut at an equal distance according to the length of each roll. Spray a small amount of water around the sampled impervious liner to prevent the bentonite from falling at the cutting place of the impervious pad, and cut the sample from the outer end 200 mm along the length direction and from the edge 100 mm along the width direction, and the measuring accuracy of the sample is 1 mm. Impurities such as thread head and rags are not allowed in the test samples of bentonite raw materials.

Table 3 Sample size and quantity of impervious liner

Item	Sample size/mm	Number of samples / piece
Tensile strength of impervious liner products	200×100	5 (Longitudinal)

Table 3 Sample size and quantity of impervious liner (continued)

Item	Sample size/mm	Number of samples / piece
Elongation of impervious liner products under maximum load	200×100	5 (Longitudinal)
Permeability coefficient of impervious liner products	Φ100	5
impervious liner products resistant to hydrostatic pressure	Φ55	5
Peel strength of nonwovens and braided fabrics	200×100	5 (Longitudinal)
Peel strength of High density Polyethylene Geomembrane and Nonwovens	200×100	5 (Longitudinal)
Quality of geosynthetics per unit area	100×100	5
Room temperature flexibility of impervious materials	200×100	5

7.5 Judgment rules

Among the 5 rolls of samples taken, if the unqualified sample roll is more than 1 roll or there are failure items in physical and mechanical properties, the qualified items shall be re-sampled and re-examined; if there is still one result that is unqualified, the batch shall be determined as unqualified. The results of the retest shall be taken as the basis for the final judgment.

8 Sign, packaging, transport and storage

8.1 Sign

8.1.1 At least the product name, mark, factory name, factory address, telephone number, production date or batch number, weight, rain and moisture protection marking should be labelled on the outer package of the impervious liner.

8.1.2 Each batch of products should be accompanied with a product certificate. The product qualification certificate shall at least be marked with the product name, mark, production date or batch number, inspection results, and inspector or institution seal.

8.2 Packaging

The impervious liner should be wrapped in waterproof material and inserted into a sturdy reel.

8.3 Transport and Storage

8.3.1 In the process of loading, unloading and transportation, impervious liners must be protected against rain, moisture and damage.

8.3.2 The impervious liner should be stored in a dry and ventilated storeroom. When stored in the open air, the bottom should be covered with moisture-proof board and the top should be covered with rain-proof cloth.

8.3.3 It is strictly forbidden to unpack the impervious liner before formal construction and laying.

Annex A
(Normative)
Determination of permeability coefficient of natural sodium bentonite impervious liner

A.1 Principle

Natural sodium bentonite impervious liner will produce tiny seepage under a certain pressure difference. The permeability coefficient can be calculated by measuring the seepage flow through the sample and the thickness of the sample within a certain time under the specified hydraulic pressure difference.

A.2 Apparatus

The apparatus for determination of permeability coefficient includes pressure system, flow measurement system and permeability chamber. The sample and permeable stone shall be placed in the permeability chamber, and the clamping part of the sample shall ensure no seepage. The principle of the apparatus for determination of permeability coefficient as shown in Figure A.1.

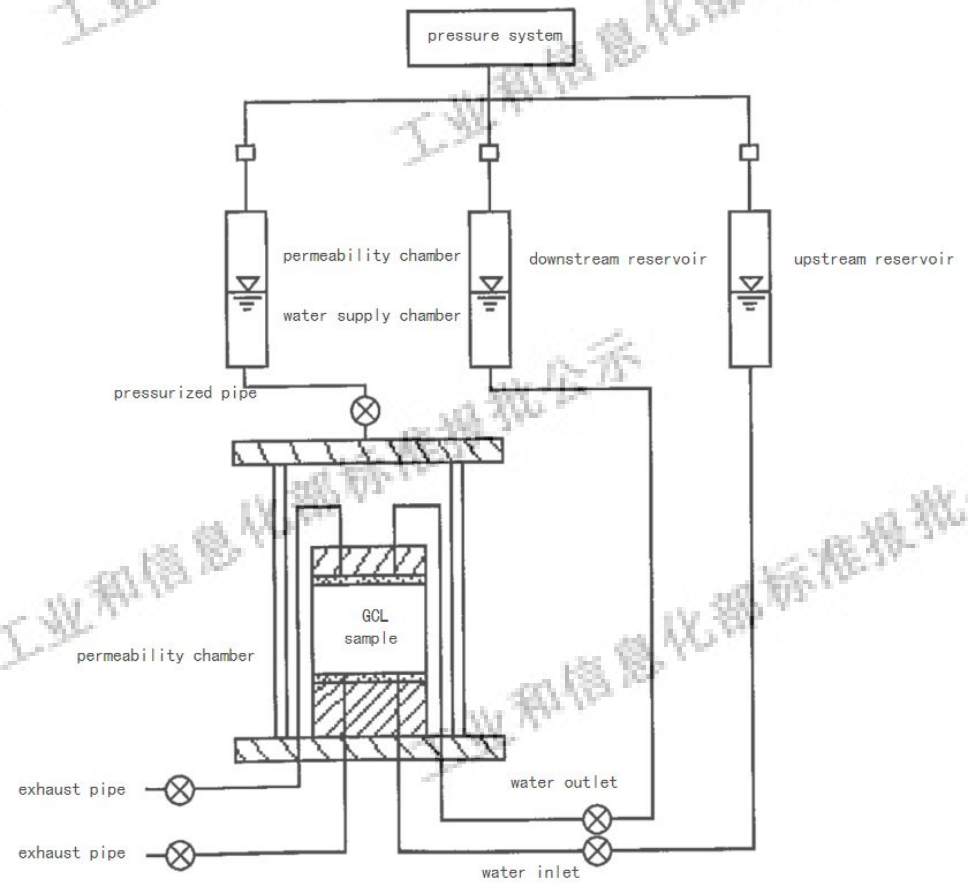


Fig.A.1 The apparatus for determination of permeability coefficient

A.3 Test procedure

A.3.1 Cut two pieces of filter paper with a diameter of 100 mm±1 mm, dip two pieces of permeable stone and filter paper in a container filled with deionized water or degassed water. Apply a thin layer of high vacuum silicone grease on the side of the bottom cover. Install a permeable stone on the base of the permeability chamber, and sandwich the sample between two pieces of filter paper and place them on the permeable stone, then put another permeable stone and install the top cover. Place flexible film around the sample (the film shall be able to withstand sufficient hydraulic pressure). Then use an O-ring expander to install the "O" ring on both ends of the sample.

A.3.2 Fill the permeability chamber with water, connect the lines between the water supply chamber and the permeability chamber, and connect the whole hydraulic system at the same time. Apply a small specified pressure to the permeability chamber (7 kPa～35 kPa) and a lower pressure to the upper and lower parts of the sample to make the water flow in the whole hydraulic system, and then open the valve on the exhaust line to discharge the visible bubbles in the water inlet, outlet, and exhaust lines, as well as the visible bubbles on the upper and lower parts of the sample in the flexible film.

Note: Degassed water or other suitable liquids can be injected into the permeability chamber, but degassed water can only be used as permeate in the flow measurement system.

A.3.3 Adjust the initial pressure of the permeability chamber to 35 kPa, and adjust the initial back pressure of the upper and lower parts of the sample to 15 kPa. Slowly pressurize the permeability chamber and the upper and lower parts of the sample and keep this state for 48 h to make the sample reach saturation state.

A.3.4 Carry out permeability measurement test. Increase the pressure of the lower part of the sample to 30 kPa, and test the permeability coefficient after the pressure is stable. Test the flow rate through the sample and the water pressure difference across the sample every 1 h.

The test can be ended when the following requirements are met:

a) The number of tests within 8 h shall not be less than 3;

b) In the last three consecutive tests, the ratio of inlet flow to outlet flow should be 0.75～1.25;

c) There should be no obvious upward or downward trend in the last three consecutive measured flow values;

d) The last three consecutive measured flow values are 0.75 times～1.25 times of the average flow value. After the test, slowly reduce the pressure acting on the inlet and outlet line. Carefully disassemble the permeameter, take out the sample, measure and record the height and diameter of the sample at the end of the test.

Note: In the process of sample saturation and permeability coefficient measurement, the maximum effective pressure applied must not exceed the pressure to solidify the sample.

A.4 Result calculation

A.4.1 Calculate the permeability coefficient k according to formula (A.1), The results retain two significant figures.

$$k = \frac{a_{in} \cdot a_{out} L}{At(a_{in} + a_{out})} \times \ln(\frac{h_1}{h_2}) \quad \text{(A.1)}$$

where

k is permeability coefficient, (m/s) ;

a_{in} is the cross-sectional area of the inlet line, (m^2);

a_{out} is the cross-sectional area of the outlet line, (m^2);

L is the sample thickness, (m);

A is the cross-sectional area of sample, (m^2);

t is the time difference between t_1 and t_2, (s);

h_1 is the water pressure difference across the sample at t_1, (m);

h_2 is the water pressure difference across the sample at t_2, (m).

When $a_{in}=a_{out}=a$, formula (A.1) can be simplified to formula (A.2):

$$k = \frac{aL}{2At} \times \ln(\frac{h_1}{h_2}) \quad \text{(A.2)}$$

A.4.2 The permeability coefficient of the sample shall be tested at 20 ℃.

When the test temperature does not meet the requirements, the permeability coefficient measured in the test shall be corrected to the permeability coefficient at 20 ℃ according to the formula (A.3), the formula is as follows:

$$k_{20} = R_T k \quad \text{(A.3)}$$

where

k_{20} is the permeability coefficient of sample at 20 ℃, (m/s) ;

R_T is the correction factor of sample permeability coefficient at different temperatures, see Table A.1;

k is the permeability coefficient of sample at test temperature, (m/s) .

Table A.1 The correction factor of sample permeability coefficient at different temperatures

Temperature, ℃	R_T	Temperature, ℃	R_T
0	1.783	25	0.889
1	1.723	26	0.869
2	1.664	27	0.850
3	1.560	28	0.832
4	1.511	29	0.814
5	1.511	30	0.797
6	1.465	31	0.797
7	1.421	32	0.764
8	1.379	33	0.749
9	1.339	34	0.733
10	1.301	35	0.719
11	1.265	36	0.705
12	1.230	37	0.692
13	1.197	38	0.678
14	1.165	39	0.665
15	1.135	40	0.653
16	1.106	41	0.641
17	1.077	42	0.629
18	1.051	43	0.618
19	1.025	44	0.607
20	1.000	45	0.598
21	0.976	46	0.585
22	0.953	47	0.575
23	0.931	48	0.565
24	0.910	49	0.556

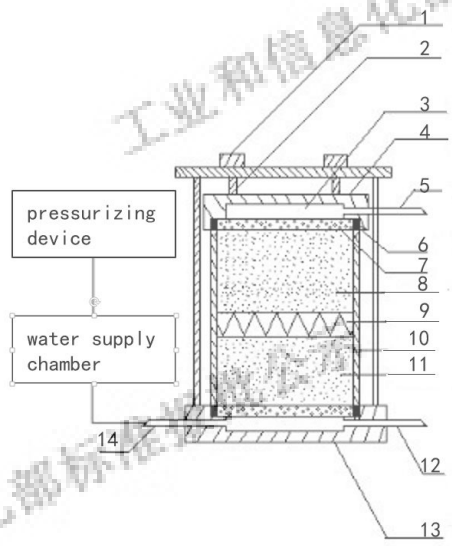
Annex B
(Normative)
Determination of hydrostatic pressure resistance of natural sodium bentonite impervious liner

B.1 Principle

When the pressure difference between the two sides of the natural sodium bentonite impervious liner reaches a certain value, the impervious liner will be destroyed. Gradually increase the hydraulic pressure difference on both sides of the sample and keep it for a certain period of time. When water flows out from the water outlet, it indicates that the sample is damaged, and the hydrostatic pressure resistance of the sample can be known.

B.2 Apparatus

The apparatus for test of hydrostatic pressure resistance is shown in Figure B.1. The permeable container is composed of permeable stone, cylinder, top cover and bottom cover.



Description of indexing serial number:

1——nut;
2——top pressure rod;
3——accumulated water chamber;
4——top cover;
5——water outlet;
6——seal ring;
7——permeable stone;
8——quartz sand;
9——GCL sample;
10——cylinder;
11——quartz sand;
12——exhaust vent;
13——bottom cover;
14——water inlet.

Fig.B.1 The apparatus for hydrostatic pressure resistance

B.3 Test procedure

B.3.1 At the position above 100 mm from the edge of the impervious liner, draw a circular arc with the same diameter as the permeable stone of the TST-55 permeameter. Drip appropriate amount of water around the circular arc with a dropper, and cut the sample according to the circular arc after 5 min.

B.3.2 Transfer the permeable stone on the bottom of the TST-55 permeameter, spread a layer of quartz sand on the permeable stone, and then place a sample on the quartz sand. The gap around the sample is filled and compacted with bentonite powder, the height of which is the same as the height of the sample. Cover the sample with fine sand, then cover with another permeable stone and the top cover, tighten the nut; Connect the TST-55 permeameter with the water supply chamber, open the valve to pressurize the water supply chamber properly. When all the gas in the permeameter is exhausted from the exhaust pipe, immediately close the exhaust pipe with a pipe clamp.

B.3.3 Keep the valve closed for 24 h to make the sample expanded fully. Then open the valve every 1 h to increase the water pressure of 0.1 MPa until the specified pressure is reached. If there is no water flowing out of the water outlet during the test, the hydrostatic pressure resistance of the sample is qualified; otherwise, the hydrostatic pressure resistance of the sample is unqualified.

Annex C
(Normative)
Determination of puncture strength of natural sodium bentonite impervious liner

C.1 Summary

Puncture mainly measures the puncture strength (T_p) of geosynthetics (such as geotextiles, geomembranes and geocomposites), expressed in Newton.

Puncture strength reflects the ability of geotextile or geomembrane to resist a small area of concentrated load such as angular stones or wood branches.

C.2 Principle

Spread the sample flat on the fixture and tighten the fixture. Push the flat-head steel rod into the sample at a certain speed until it punches through the sample, and record the maximum pressure value.

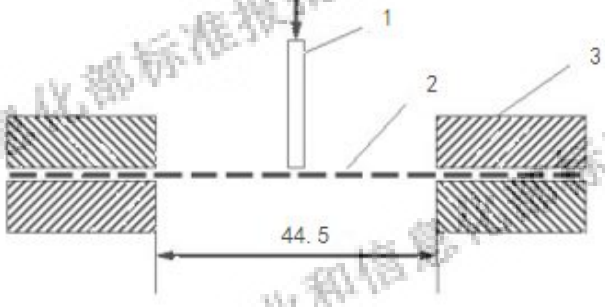
C.3 Fixture and apparatus

C.3.1 Tensile machine: stretching through strip-like method and equipped with a reverser.

C.3.2 Ring fixture: the inner diameter is 44.5 mm, as shown in figure C.1.

C.3.3 Rigid ejector: the diameter is 8 mm, flat-head.

in millimeters



Description of indexing serial number:

1——ejector;

2——sample;

3——ring fixture.

Fig.C.1 Diagram of puncture test

C.4 Sample preparation

C.4.1 Cutting of the sample shall be in accordance with the SL/T 237.

C.4.2 Five samples shall be taken from each group of experiments, and the size of which should match the ring fixture.

C.5 Testing procedure

C.5.1 Transfer the sample into the ring fixture and lay the sample flat, then tighten the fixture.

C.5.2 Put the fixture on the pressurizing device, center it, and set the maximum puncture rate to 100 mm/min.

C.5.3 Turn on the machine and record the maximum pressure value during the process of the maximum puncture.

C.5.4 Repeat steps C.5.1～C.5.3 to test the remaining samples.

C.6 Calculation

Puncture strength (T_p): The average value of the maximum puncture force of all samples, the unit is Newton (N), and the result is kept two decimal places.

Annex D
(Informative)
Identification method of natural sodium bentonite and artificial sodium bentonite

D.1 X-ray diffraction (XRD)

D.1.1 Apparatus

D.1.1.1 Acidity meter: the accuracy of pH is 0.01.

D.1.1.2 High-speed centrifuge: rotation speed ≥ 10000 r/min.

D.1.1.3 X-ray diffraction (XRD).

D.1.1.4 Electric drying oven: the temperature range is 0 ℃～300 ℃, the sensitivity is±2 ℃.

D.1.2 Testing procedure

D.1.2.1 Rinse the bentonite sample with distilled water. After rinsing, centrifuge the sample for 5 min±1 min under the condition of the speed of high-speed centrifuge no less than 8000 r/min. At least 4 times of rinsing and centrifugation shall be carried out until the pH of the aqueous solution is 7～8.

D.1.2.2 Place the bentonite sample that meeting the requirements of D.1.2.1 in an electric drying oven at 60 ℃±2 ℃ until the sample is dried.

D.1.2.3 Measure the diffraction characteristic peaks of montmorillonite on the dried bentonite sample.

D.1.2.4 The diffraction characteristic peak d (001) of montmorillonite in natural sodium bentonite is 12.5 Å; The diffraction characteristic peak d (001) of artificial sodium bentonite is 13.8 Å～15 Å.

D.2 Change rate of expansion index

The determination of change rate of expansion index shall be in accordance with 6.3. The change rate of expansion index of natural sodium bentonite is not less than 80% and the change rate of expansion index of artificial sodium bentonite is not more than 50%.