



BentoShield®
**GEOSYNTHETIC
CLAY LINERS**



GEOMAS BENTOSHIELD

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R-A

**MANUFACTURING
QUALITY ASSURANCE
and
QUALITY CONTROL
MANUAL**



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SECTION 1: INTRODUCTION TO MANUFACTURING QUALITY CONTROL

1.1 Scope of the this manual

BentoShield parties and the raw materials are subjected to compliance tests in specified frequencies according to GEOMAS Manufacturing Quality Control Plan and as well as the specification of customers .

In this regard, this manual indicates the manufacturing quality control process of GEOMAS geosynthetic clay liners (GCLs), describing types of tests, the proper test methods, minimum and sometimes maximum values, and the minimum testing frequencies.

In addition, this manual also emphasizes the prominence of manufacturing techniques that affects the quality of product directly. For instance, the frequency of wholly changing the needles in the needle loom is one of the most critical parameter affecting the quality production.

Consequently, all the steps of production phase is monitored according to the detailed explanations in Geomas Quality Control Plan. This Quality Control Plan is consisted of general instructions for prior, during and after the production, maintenance schedule of needle loom and the rest of the line, tasks of the employee and recording method of all datas for traceability.

1.2 Reference Test Methods and Standards

Upon Request those standards are available in GEOMAS archive.

ASTM C136 Standard Practice for Sieve Analysis of Fine and Coarse Aggregates
ASTM D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4643 Determination of Moisture Content of Soil by the Microwave Oven Method
ASTM D5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles
ASTM D5261 Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
ASTM D5321 Standard Test Method for Direct Shear of Geosynthetics
ASTM D5887 Standard Test Method or Measurement of Index Flux Through Saturated GCL Specimens Using a Flexible Wall Permeameter
ASTM D5889 Standard Practice for Quality Control of GCLs
ASTM D5890 Standard Test Method for Swell Index Measurement of the Clay Mineral Component of GCLs
ASTM D5891 Standard Test Method for Measurement of Fluid Loss of Clay Mineral Component of GCLs
ASTM D5993 Standard Test Method for Measuring the Mass Per Unit of GCLs
ASTM D6243 Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method



ASTM D6496 Standard Test Method for Determining Average Bonding Peel Strength
Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
ASTM D6768 Standard Test Method for Tensile Strength of Geosynthetic Clay Liners

1.3 Quality Commitment of GEOMAS in accordance to MQC/MQA

The entire manufacturing process of GEOMAS is controlled and monitored through the implementation of a detailed quality management system.

GEOMAS has ISO 9001:2008 quality management system certified by Bureau Veritas. This management system is also integrated with our MQC and Quality Control Plans to ensure the best quality products to our customers. All components of ISO 9001 system such as the manual, work instructions and procedures are contributory to MQC.

In addition to ISO 9001, CE and GOST-R add value to our quality understanding and creates an opportunity to test the overall efficiency of the overall MQC System by third-party investigations and audits.

Corrective and preventive actions can be taken according to the results of those audits.

SECTION 2: MANUFACTURING QUALITY CONTROL

2.1 Testing of GCL Components

MQC procedures and tastings are carried out on all raw material components as well as the finished BentoShield rolls. BentoShield rolls are subject to tests in defined periods as in quality control plan before shipped to the customers.

Non-woven geotextile, woven geotextile and granular sodium bentonite are the main raw materials, which are subject to testing and quality procedures before taking into production.

Most of the tests are realized at the manufacturing locations in Istanbul and Izmir of Izomas Group and some tests are realized in accredited laboratories in USA and England.

2.1.1 Woven and Non-Woven Geotextiles

GEOMAS geosynthetic clay liners may consist of either the combination of the non-woven and woven geotextiles or merely two non-woven geotextiles in the bottom and at the top.

In black woven geotextile, two blue dashed in both sides assist for proper overlapping area. Those lines take place 15 and 25 cm away from the edges.

Both needlepunched non-woven and woven geotextiles constituted of polypropylene fabrics and only polypropylene geotextiles are preferred because of the superior characteristics against polyester fabrics.

Geomas manufacturing process is able to supply woven and non-woven rolls up to 2000 meter.

Though there is no direct effect on quality, Geomas mostly prefer bigger rolls to fasten the production and eliminate the repeated actions during production.

Geomas works with only approved suppliers. In order to be an approved geotextile supplier, passing once the laboratory tests by fulfilling the Geomas specifications and having own certified quality control system is required.

For each shipment, the approved suppliers send their testing results as a statement for meeting the requirements of Geomas. Besides testing in determined frequencies, supplier should also indicate the properties of each roll by labeling with a lot number, roll number, production date, length and the tested values.

Before the roll is placed into production, Geomas Quality Executive gives a separate batch number in order to monitor the source of raw materials in finished GCL.

Besides the tests of the approved supplier, Geomas also examine the properties of geotextiles in determined frequencies or as a result of Quality Control Manager decision.

The table 2.1 shows the related test methods, frequencies of test and the required minimum and maximum values for testing the geotextile components of BentoShield.

Table 2.1 – MQA parameters for geotextiles

PROPERTY	TEST METHOD	FREQUENCY OF TEST	REQUIRED VALUE
Mass per unit Area	ASTM D 5261	20.000 m ²	MARV
Tensile Strength	ASTM D 4643	20.000 m ²	Typical and MARV
Static Puncture	EN ISO 12236	200.000 m ²	MARV

2.1.2 Sodium Bentonite Granules

Because of the several technical considerations during production and application of GCL, Geomas use only sodium bentonite in granule form and in specified residues.

Geomas supply bentonite both from local and foreign producers through containers which Though one time orders may be in huge quantities such as 5 containers, Geomas apply the tests according to weight not the number of the order. Consequently Geomas tests the specified values of bentonite in every 20 tons. In case of not meeting the requirements, action is taken depending on Non-Conforming Material Procedure, supplier is informed about the non-conformity.

For sodium bentonite, swell index and fluid loss are the primary indicative properties directly influencing the performance of GCL. Swell index and fluid loss tests are performed in accordance of ASTM D 5890 and ASTM D 5891 respectively in Geomas facilities.

Because of the pre-hydration process, moisture content should be around %10 in bentonite in order to provide around %15 moisture content in finished GCL.

As a result, Geomas supplies bentonite from only approved suppliers stating minimum 24 mL/2g swell index value, maximum 18 mL fluid loss value and %10 moisture content.

As similar to geotextiles, separate batch number is given to bentonite parties in order to monitor the source of raw material in the finished GCL. According to this batch number, we can reach the related test reports, small quantity of representative sample, daily consumption rate from exact party and remaining inventory.

The table 2.2 shows the related test methods, frequencies of test and the required minimum and maximum values for testing the bentonite granules.

Table 2.1 – MQA parameters for sodium bentonite granules

PROPERTY	TEST METHOD	FREQUENCY OF TEST	REQUIRED VALUE
Swell Index	ASTM D 5890	every 20 tons	≥ 24 ml / 2g
Moisture Content	ASTM D 4643	every 20 tons	≤ 12 %
Fluid Loss	ASTM D 5891	every 20 tons	≤ 18 ml
MBI	ASTM C 837	every 20 tons	$\geq 2,5$ Meq/100 gr

2.2 Tests on BentoShield

The MQC document is fully implemented and followed prior, during and after the production. Consequently, all BentoShield parties produced in accordance to MQC and subject to testing in determined frequencies in order to ensure minimum and maximum specified values.

GEOMAS performs regularly those tests:

1. Peel Strength ASTM D 6496

This test covers the average bonding strength between the top and bottom layers. This test is one of the prominent test of GCLs.

2. Mass per unit area according to ASTM D 5993

Mass per unit area test, controls the quantity of dry bentonite content within the GCL and its correlation with the indicated value in BentoShield data sheet.

3. Moisture Content according to ASTM D 4643

Moisture content should be as stated in product data sheets.

4. Permeability ASTM D 5887

This test covers the laboratory measurement of flux through saturated Bentoshield specimens using a flexible wall permeameter.

5. Tensile Strength ASTM D 4632

All the details of those testing procedures are explained in GEOMAS work instructions. Please refer to work instructions for further information.

Geomas also sends samples regularly to accredited test laboratories in order to test internal shear test according to ASTM D6243. This test method determines the internal shear

resistance of BentoShield or the interface shear resistance between the GCL and adjacent material under a constant rate of displacement or constant stress.

The applicable test method, frequencies and the required values are listed in the table:

Table 2.3 – MQA parameters for BentoShield

PROPERTY	TEST METHOD	FREQUENCY OF TEST	REQUIRED VALUE
Bentonite Mass per Area	ASTM D 5993	4.000 m ²	Depends on product
Tensile Strength	ASTM D 4632	20.000 m ²	53 N/cm
Peel Strength	ASTM D 6496	4.000 m ²	4.4 N/cm
Permeability	ASTM D 5887	periodic	5 x 10 ⁻⁹ cm/sec max
Internal Shear Strength	ASTM D6243	periodic	24 kPa

2.2.1 Sampling from BentoShield

In order to take samples without interrupting the production flow, operator produces some rolls longer and excessive part is cut automatically before packaging.

Operator indicates the roll number in records when forming the log of the sample and delivering to Quality Control Executive. By the help of that roll number, all other information can be filtered from the computer system. In case of need for reference, the sample is saved by Quality Control Executive for 3 years, whereas the data are saved for 5 years.

2.3 Adjustments on machinery

According to the directions of Production Manager, operator adjust the calibration of the machinery such as operating speed, needlepunching density, penetration depth of the fibers, moisture content, bentonite dosage and etc. Those parameters determine the physical characteristics of GCL such as peel strength and internal shear.

Consequently Geomas determined also minimum calibration values to set as a standard.



2.4 Replacement of Needles

During needlepunching process, all needles wear off after a while and whereas some of them may also break down. Consequently, needles current condition affects the puncture quality and the peel strength correspondingly.

Depending on type production this phenomenon happens slower or faster, so Geomas totally renew the needles in exact periods in accordance to the type of BentoShield.

2.5 Dimensions of BentoShield

Roll length and width are continuously monitored by electronic devices in order to provide standard rolls with minimum 40 meter length and 5 meter width. Although width of the geotextiles pass through the needlepunching machine is longer than 5 meter, excessive sides are cut in order to provide safe edges.

Additionally, other dimensions can be also arranged in the cutting line upon request.

2.6 Maintenance of Production Line and Equipments

All mechanical component of the production line and all equipment used are regularly inspected and maintained in accordance with Geomas Quality Control Plan. Constraints are detailed for the maintenance of machinery in terms of working hour and yearly basis.

2.7 Polymerization

As a patented and confidential system, Geomas add polymers to GCL to enhance the unique sealing properties of sodium bentonite even in harsh contaminated conditions. The type of polymers and method of polymerization is confidential information.

SECTION 3: TRACEABILITY OF PRODUCTS AND RECORDS

3.1 Daily Production Records

Manufacturing line is fully automated which means that workers are only feeding the line with raw materials and the rest of the process from the beginning of the production to the end including packaging is completed automatically by the system.

The inputs and outputs of the daily operation can be saved and monitored day by day from the computer system of the manufacturing line.

After the machinery calibration of the line, operator only enters the batch numbers of the raw materials and a report can be printed as the summary of day.

Daily production log include those information:

- Date
- Operator
- Production Order Number
- List of Lot and roll numbers in production.
- Weight, length and width of each roll produced
- Bentonite content in each roll
- Bentonite and geotextile consumption during the day

Besides all those automated data, operator also records the relevant information affecting the production such as the reason and duration of the stops.

3.2 Roll Identification and Labeling

After the production process, every roll is labeled and stored in particular areas before shipment.

Label is clearly located at the clearly visible top surface of the plastic protective wrap of each roll. This label helps to easily identify the following information:

- Weight, length and width of the roll
- Trademark of the GEOMAS GCL
- Lot and roll number
- Location of production and producer
- Batch numbers of the raw materials
- Related certificate sign such as CE, GOST-R, BBA

By labeling the delivered rolls, the particular lot of bentonite and the geotextiles used in the production can be easily identified.



3.3 Laboratory Records

Geomas sends the Quality Control Test results in its own format to the customers performed in its laboratory. In case of demand Geomas also may perform some tests in accredited laboratories.

In general, GEOMAS presents all test results to the customers about the properties of the finished product and the raw materials by indicating those data:

- Date
- Sample roll number
- Related test standard
- Reference minimum and maximum values
- Tested Values
- The name and sign of Quality Control Executive

Depending on the quantity of the order, Geomas may send several test results to the customer with each shipment that performed in defined frequencies.

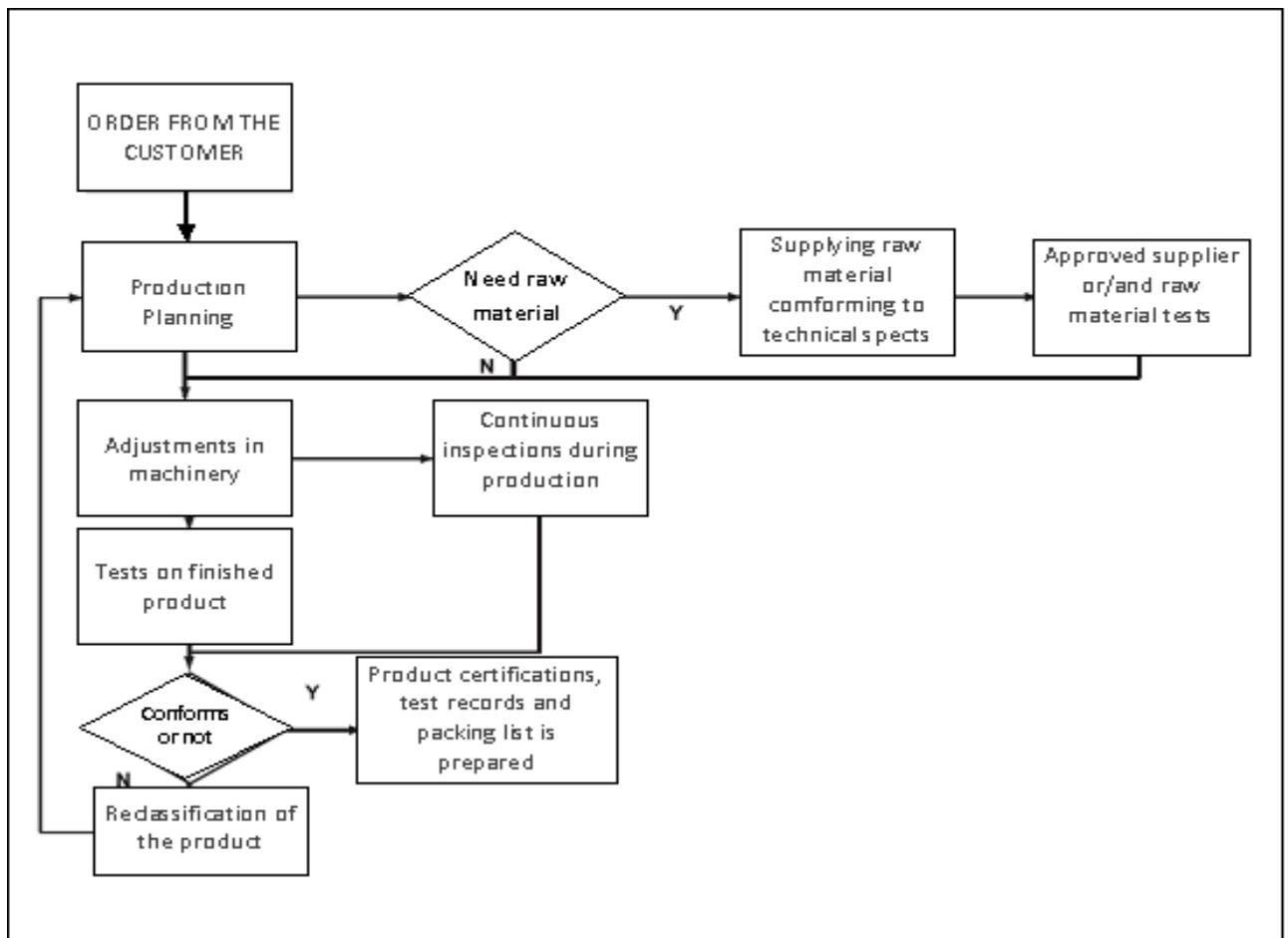
3.4 GCL Manufacturing Certification Reports

GEOMAS sends the quality Control Reports and certificates for each delivered party of materials. Besides the quality control report also those documents are send:

- Shipment Packing List - GCL lot and roll numbers supplied in a particular truckload.
- Bill of Lading - The shipping documents for the truck used for the shipment.
- Letter of Certification - The letter indicating the material is in conformance with the physical properties specified.
- Product Data Sheet - The material specification for the GCL supplied in accordance with this specification.

APPENDIX A

SIMPLE PRODUCTION FLOW CHART



APPENDIX B

BENTOSHIELD 5000 MQA DATA SHEET

PROPERTY	TEST METHOD	FREQUENCY OF TEST	TESTED VALUE
GEOTEXTILE PROPERTY			
Woven, Mass/Unit Area	ASTM D 5261	20.000 m ²	110 g/m²
Nonwoven, Mass/Unit Area	ASTM D 5261	20.000 m ²	200 g/m²
BENTONITE PROPERTY			
Swell Index	ASTM D 5890	every 20 tons	≥ 24 ml / 2g
Moisture Content	ASTM D 4643	every 20 tons	≤ 12 %
Fluid Loss	ASTM D 5891	every 20 tons	≤ 18 ml
MBI	ASTM C 837	every 20 tons	≥ 2,5 Meq/100 gr
BENTOSHIELD 5000			
Bentonite, Mass/Unit Area ⁽¹⁾	ASTM D 5993	4.000 m ²	5000 g/m²
Tensile Strength	ASTM D 4632	20.000 m ²	13 kN/m
Peel Strength	ASTM D 6496	4.000 m ²	60 N/m
Permeability	ASTM D 5887	periodic	5 x 10⁻¹¹ m/sec max
Internal Shear Strength	ASTM D6243	periodic	24 kPa
ROLL DIMENSIONS			
Width and Length	Typical	Every Roll	5 m x 40 m
Area of each roll	Typical	Every Roll	200 m²
Approximate Weight	Typical	Every Roll	1100 kg